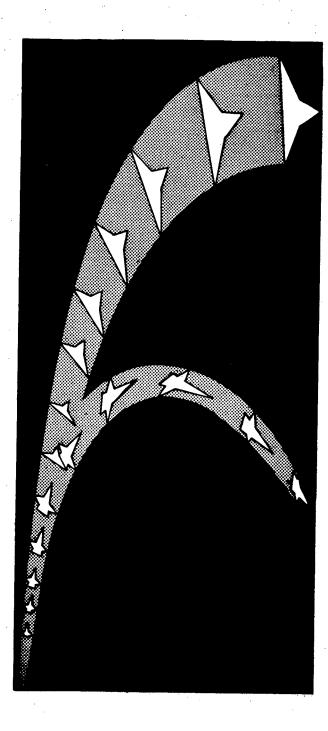
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DMS-DR-1259 CR-120,066 JANUARY 1973



SADSAC SPACE SHUTTLE AEROTHERMODYNAMIC DATA MANAGEMENT SYSTEM

CONTRACT NASS-4016
MARSHALL SPACE FLIGHT CENTER



-SPACE SHUTTLE-

PRELIMINARY PRESSURE
DISTRIBUTIONS ON THE 049
ORBITER, ORBITER IN PRESENCE
OF H/O TANK AND ORBITER
IN LAUNCH CONFIGURATION

by

J. T. Hamilton, NSI

J. M. Rampy, NSI

J. F. Sims, MSFC

MSFC 14 X 14-INCH
TRISONIC WIND TUNNEL

Marshall Space Flight Center

NASA

This document should be referenced as NASA CR-120,066 ELIMINARY PRESSURE DISTRIBUTIONS ON THE ORBITER, ORBITER IN PRESENCE OF H/OWK AND ORBITER IN LAUNCH (Chrysler 19.) 208 p.HC \$12.50

N73º20890

DMS-DR-1259 NASA CR-120,066 January, 1973

SADSAC/SPACE SHUTTLE

WIND TUNNEL TEST DATA REPORT

•	
CONFIGURATION:0	04 SCALE 049 ORBITER AND LAUNCH CONFIGURATION
TEST PURPOSE: DE	TERMINE PRELIMINARY PRESSURE DISTRIBUTIONS ON THE 049 ORBITER
OR	BITER IN PRESENCE OF THE H/O TANK AND IN LAUNCH CONFIGURATION
TEST FACILITY: NA	SA/MSFC 14 X 14-INCH TRISONIC WIND TUNNEL
TESTING AGENCY:	NASA/MSFC
TEST NO. & DATE:	MSFC TWT 540, APRIL 28, 1972 - JUNE 9, 1972
FACILITY COORDINATO	R: Jim Weaver
PROJECT ENGINEER(S)	J. T. Hamilton, NSI
	J. F. Sims, MSFC
	J. M. Rampy, NSI
	DATA MANAGEMENT SERVICES
LIAISON: Y. W.	Sarks DATA OPERATIONS: HC Zurumerle

CONTRACT NAS 8-4016

RELEASE APPROVAL:

AMENDMENT 182

N. D. Kemp, Supervisor Aero Thermo Data Group

DRL 297 - 84a

C.)Zimmerle

This report has been prepared by Chrysler Corporation Space Division under a Data Management Contract to the NASA. Chrysler assumes no responsibility for the data presented herein other than its display characteristics.

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TABLE OF CONTENTS

			Page
ABST	RACT		1
NOME	NCLATUI	RE	2
CONF	IGURAT:	IONS INVESTIGATED	4
TEST	FACIL	ITY DESCRIPTION	. 5
DATA	REDUC'	ITON	6
TABL	es:		
	I	ORBITER WING AND FUSELAGE PRESSURE TAP LOCATIONS	7
	II	TEST CONDITIONS	8
	III	DATA SET COLLATIONS	9
	IV	DIMENSIONAL DATA	10
	٧ .	INDEX OF MODEL FIGURES	16
	VI	INDEX OF DATA FIGURES	17
FIGUI	RES		
	MODEL		18
	рата	·	. 93

PRELIMINARY PRESSURE DISTRIBUTIONS ON THE 049 ORBITER, ORBITER IN PRESENCE OF H/O TANK AND ORBITER IN LAUNCH CONFIGURATION

By J. T. Hamilton, J. F. Sims and J. M. Rampy

ABSTRACT

The O49 orbiter and launch configurations were tested in the MSFC Trisonic Wind Tunnel to obtain preliminary loads information on the orbiter alone, orbiter in presence of the H/O tank and orbiter in the full launch configuration. The orbiter consisted of the baseline O49 double-delta wing, twin vertical stabilizers, seven degrees of dihedral and included abort rockets. The orbiter was mounted at -1.5° of incidence (fuselage centerline relative to H/O tank centerline) in the launch configuration. The SRM's were mounted at a radial location of 21 degrees from the horizontal centerline of the H/O tank.

The test was conducted in the NASA/MSFC 14 x 14 inch Trisonic Wind Tunnel over a Mach Number range of 0.6 to 4.96. Nominal angle of attack and angle of sideslip ranges of -6 to +6 degrees were tested. In addition, the orbiter alone was tested over an angle of attack range of -6 to +26 degrees.

NOMENCLATURE General

SYMBOL	SADSAC SYMBOL	DEFINITION
а		speed of sound; m/sec, ft/sec
c_p	CP	pressure coefficient; $(p_1 - p_{\omega})/q$
M	MACH	Mach number; V/a
р		pressure; N/m ² , psf
Q	Q(NSM) Q(PSF)	dynamic pressure; 1/2 pV2, N/m2, psf
RN/L	RN/L	unit Reynolds number; per m, per ft
v		velocity; m/sec, ft/sec
α	ALPHA	angle of attack, degrees
β	BETA	angle of sideslip, degrees
ψ	PSI	angle of yaw, degrees
ϕ	PHI	angle of roll, degrees
· p		mass density; kg/m^3 , $slugs/ft^3$
	Refe	rence & C.G. Definitions
$A_{\mathbf{b}}$.		base area; m ² , ft ²
Ъ	BREF	wing span or reference span; m, ft
c.g.		center of gravity
$\underline{m{\ell}}_{ ext{REF}}$	LREF	reference length or wing mean aerodynamic chord; m, ft
S	SREF	wing area or reference area; $\mathtt{m}^2,\ \mathtt{ft}^2$
	MRP .	moment reference point
	XMRP .	moment reference point on X axis
	YMRP	moment reference point on Y axis
	ZMRP	moment reference point on Z axis
SUBSCRIPTS		
b 1.		base local
s		static conditions
t œ		total conditions free stream

ADDITIONS TO NOMENCLATURE FOR MSFC TWT 540

SYMBOL	SADSAC SYMBOL	DEFINITION
c	С	local chord length.
x	x	pressure tap location in the longitudinal direction measured from the nose and from the wing leading edge.
У	Y	pressure tap location in the lateral direction measured from the fuselage centerline.
$ heta_{S}$	SANGLE	radial positions of the SRM boosters relative to HO tank, measured from tank horizontal centerline.
i _o	ORBINC	incidence angle between the orbiter and the HO tank.
x/c	x/c	local chordwise position/local chord length.
$\frac{\mathbf{x}}{\mathbf{l}_{\mathrm{B}}}$	x/L	longitudinal position/body length.
y/(b _{ref} /2)	Y/ В	local spanwise position/wing semi-span.

CONFIGURATIONS INVESTIGATED

Test results reported herein were obtained on the 0.004 scale 049 orbiter and launch configuration (Figures 1-5). Each of the model components tested is listed below. The dataset collation sheets show the combinations (Table III). Dimensional data for the components are given in Table IV.

MODEL COMPONENT SYMBOL	DESCRIPTION
01	Baseline 049 Orbiter (BlW4V11)
Rl	Abort rockets
Tl	346-Inch Diameter H/O Tank with 220
	nosecone
Sl	156-Inch Diameter Solid Rocket with
	17° Nosecone

TEST FACILITY DESCRIPTION

The Marshall Space Flight Center 14" x 14" Trisonic Wind Tunnel is an intermittent blowdown tunnel which operates by high pressure air flowing from storage to either vacuum or atmospheric conditions. A Mach number range from .2 to 5.85 is covered by utilizing two interchangeable test sections. The transonic section permits testing at Mach 0.20 through 2.50, and the supersonic section permits testing at Mach 2.74 through 5.85. Mach numbers between .2 and .9 are obtained by using a controllable diffuser. The range from .95 to 1.3 is achieved through the use of plenum suction and perforated walls. Mach numbers of 1.44, 1.93 and 2.50 are produced by interchangeable sets of fixed contour nozzle blocks. Above Mach 2.50 a set of fixed contour nozzle blocks are tilted and translated automatically to produce any desired Mach number in .25 increments.

Air is supplied to a 6000 cubic foot storage tank at approximately -40°F dew point and 500 psi. The compressor is a three-stage reciprocating unit driven by a 1500 hp motor.

The tunnel flow is established and controlled with a servo actuated gate valve. The controlled air flows through the valve diffuser into the stilling chamber and heat exchanger where the air temperature can be controlled from ambient to approximately 180°F. The air then passes through the test section which contains the nozzle blocks and test region.

Downstream of the test section is a hydraulically controlled pitch sector that provides a total angle of attack range of 20° ($\pm 10^{\circ}$). Sting offsets are available for obtaining various maximum angles of attack up to 90° .

DATA REDUCTION

All static pressures were reduced to the form of pressure coefficients by referencing them to freestream static pressure and dividing by freestream dynamic pressure:

$$CP = (P_{\ell} - P_{\infty})/q$$

Table 1 lists positions of the individual surface pressure taps. The positions are non-dimensionalized by wing semi-span in the lateral direction and by body length and by local chord length in the longitudinal direction.

Table 1
ORBITER SURFACE PRESSURE TAP LOCATIONS

Ta	p No.		,	L _{local}	.5b _{ref}
Upper	Lower	X/L	Y/.5b	(in.)	(in.)
-	11	.046	0.0	5.26	2.23
-	12	.092			
-	13	.152			
	14	.228			
_	15	.304			
_	16	.456			
_	17	.947		į į	
6	18	.144	.282	3.306	
7	19	.300		1	
8	20	.470			
9	21	.642			
10	22	.814		• •	
3	23	.229	.553	1.641	
4	24	.515	1 1		
5	25	.729		• [
1	26	.216	.842	.962	
2	27	.721	₩	•	•

TABLE II

TEST CONDITIONS TEST TWT-540

MACH NUMBER	REYNOLDS NUMBER per unit length	DYNAMIC PRESSURE (pounds/sq. inch)	STAGNATION TEMPERATURE (degrees Fahrenheit)
0.6	4.50	3.97	100
0.8	5.50	5.90	100
0.9	5.90	6.71	100
1.1	6.10	7.98	100
1.2	6.20	8.34	100
1.96	7.10	10.23	100
2.74	4.70	6.35	100
4.96	5.10	3.07	140
,			
		·	

BALANCE UTILIZED:	PRESSURE TEST	
CAPACITY:	ACCURACY:	COEFFICIENT TOLERANCE:
NF	_	
SF		-
AF		
PM		
YM		
RM		
		
COMMENTS:		

TABLE III

TEST MSFC 1WT 540 DATA SET/RUN NUMBER

DATA SET IDENTIFIER R67001 TAPN COEFFICIENTS: 004 0/4 006 005 003 0 02 008 0// 515 009 007 013 7101 7/0/ OCONFIGURATION 101R1 70/S CP SCHD. α P ρ α Ø P α I 19 Ø D 0 PARAMETERS / VALUES COLLATION SUMMARY 31 NO. of RUNS 42 42 24 42 42 42 24 (1 WB 37 MACH NUMBERS 43 18 OR ALTERNATE 356 346 6 1 160 19 S, 612 622 IDPVAR(1) IDPVAR(2) NDV VARIABLE M POSTTEST O PRETEST 67 LEST RUN NUMBERS 9

a or β SCHEDULES

QAII xB1

6

28 !!

U O

かつまし

BD=-60 TO

08=6

NASA-MSFC-MAF

QE"

TABLE IV DIMENSIONAL DATA

MODEL COMPONENT: BODY - B1

GENERAL DESCRIPTION:	Basic orbiter b	ody including canopy a	and manipulator
arm housing.	,		
	·		
DRAWING NUMBER			
DIMENSION:	-	THEORET	MODEL SCALE
Length .		1315 in.	(.004) 5.260,in.
Max Width (P. L.)	Bay/Base)	208/220 in.	.832/880 in.
Max Depth		235 in	.940 in.
Fineness Ratio		6.32	6.32
Area			
Max Cross-Sect	ional		
Planform	•		
Wetted		6250 ft. ²	14.40 in. ²
Base Projected	i	317.7 ft. ²	732 in ²

TABLE IV (CONTINUED)

MODEL COMPONENT: W4	
GENERAL DESCRIPTION: Double Delta Wing	
•	· · · · · · · · · · · · · · · · · · ·
	-
DRAWING NUMBER:	•
District No.	THEORETICAL
DIMENSIONS:	FULL-SCALE MODEL SCALE (.004)
TOTAL DATA	χ
Planform Basic/Glove Wetted Basic/Glove Span (equivalent) Aspect Ratio Basic/Flove Rate of Taper Taper Ratio Basic/Glove Dihedral Angle, degrees Incidence Angle, degrees Aerodynamic Twist, degrees Toe-In Angle Cant Angle Sweep Back Angles, degrees Leading Edge Basic/Glove Trailing Edge 0.25 Element Line Chords: Root (Wing Sta. 0.0) B/G Tip, (equivalent) MAC Basic Fus. Sta. of .25 MAC W.P. of .25 MAC Airfoil Section Root Tip	3420/1187 ft. ² 1925/819 ft. ² 1115 in. 2.5/1.9
EXPOSED DATA	2010 05/2055 012 0 006/2 0-1
Area Basic/Glove Span, (equivalent) Aspect Ratio Taper Ratio Chords Root Basic/Glove Tip	1218.95/16255 ft? 2.806/0.374 in. 3 453.5 in. 1.814 in
MAC Fus. Sta. of .25 MAC W.P. of .25 MAC B.L. of .25 MAC	

TABLE IV (CONTINUED)

DRAWING NUMBER: THEORETICAL	MODEL COMPONENT: V11	/	
DRAWING NUMBER: THEORETICAL	GENERAL DESCRIPTION: Twin vertical tails	(Dimensions are for a	single panel.)
DIMENSIONS: FULL-SCALE MODEL SCALE			
DIMENSIONS: FULL-SCALE MODEL SCALE			
DIMENSIONS: FULL-SCALE MODEL SCALE	DRAWING NUMBER:	THEORES	TCAT.
TOTAL DATA	DIMENSIONS:		
Planform Wetted 525 ft.2 1.21 in.			
Wetted Span (equivalent)			
Span (equivalent)		-	
Aspect Ratio Rate of Taper Taper Ratio Dihedral Angle, degrees Incidence Angle, degrees Aerodynamic Twist, degrees Toe-In Angle Cant Angle Sweep Back Angles, degrees Leading Edge Trailing Edge O.25 Element Line Chords: Root (Wing Sta. 0.0) Tip, (equivalent) MAC Fus. Sta. of .25 MAC Airfoil Section Root Tip EXPOSED DATA Area Span, (equivalent) Aspect Ratio Taper Ratio Chords Root Root Root Root Root Area Span, (equivalent) Aspect Ratio Taper Ratio Chords Root Root Root Root Root Root Aspect Ratio Tip Aspect Ratio Chords Root Root Root Root Root Root Aspect Ratio Chords Root R		525 ft.2	1.21 in.2
Rate of Taper	Aspect Patio		
Taper Ratio		-	
Dihedral Angle, degrees	Taper Ratio		
Incidence Angle, degrees			
Toe-In Angle Cant Angle Sweep Back Angles, degrees Leading Edge Trailing Edge 0.25 Element Line Chords: Root (Wing Sta. 0.0) Tip, (equivalent) MAC Fus. Sta. of .25 MAC W.P. of .25 MAC B.L. of .25 MAC Airfoil Section Root Tip EXPOSED DATA Area Span, (equivalent) Aspect Ratio Taper Ratio Chords Root Root Root Root Root Root Root Tip EXPOSED DATA Area Span, (equivalent) Aspect Ratio Taper Ratio Chords Root Root Root Root Root Root Root Roo	Incidence Angle, degrees		00
Cant Angle Sweep Back Angles, degrees Leading Edge O.25 Element Line Chords: Root (Wing Sta. 0.0) Tip, (equivalent) MAC Fus. Sta. of .25 MAC W.P. of .25 MAC B.L. of .25 MAC Tip Root Tip Root Tip Span, (equivalent) Area Span, (equivalent) Area Span, (equivalent) Aspect Ratio Taper Ratio Chords Root Root Tip Tip Sound Tip			00
Sweep Back Angles, degrees 45° 45° 45° Trailing Edge			
Leading Edge		15°	15°
Trailing Edge	Sweep Back Angles, degrees		١-0
0.25 Element Line Chords: Root (Wing Sta. 0.0) Tip, (equivalent) MAC Fus. Sta. of .25 MAC W.P. of .25 MAC B.L. of .25 MAC Airfoil Section Root Tip EXPOSED DATA Area Span, (equivalent) Aspect Ratio Taper Ratio Chords Root Tip Sout Span (250 ft. 2 250 ft. 2 250 ft. 2 250 ft. 3	Leading Edge Thailing Edge	209	
Chords: Root (Wing Sta. 0.0) Tip, (equivalent) MAC Fus. Sta. of .25 MAC W.P. of .25 MAC B.L. of .25 MAC Airfoil Section Root Tip EXPOSED DATA Area Span, (equivalent) Aspect Ratio Taper Ratio Chords Root Root Tip Span (Sequivalent) Aspect Ratio Taper Ratio Chords Root Root Tip Span (Sequivalent) Aspect Ratio Taper Ratio Chords Root Tip Span (Sequivalent) Aspect Ratio Span (Sequivalent) Aspect Ratio Span (Sequivalent) Aspect Ratio Span (Sequivalent) Span (Sequivalent) Aspect Ratio Span (Sequivalent) Span (Sequivalent) Aspect Ratio Span (Sequivalent) Aspect Ratio Span (Sequivalent) Aspect Ratio Span (Sequivalent) Span	0 25 Flement Line		
Root (Wing Sta. 0.0) Tip, (equivalent) MAC Fus. Sta. of .25 MAC W.P. of .25 MAC B.L. of .25 MAC Airfoil Section Root Tip EXPOSED DATA Area Span, (equivalent) Aspect Ratio Taper Ratio Chords Root Tip Sout 230 in. 80 in. 0.320 in.			
Tip, (equivalent) MAC Fus. Sta. of .25 MAC W.P. of .25 MAC B.L. of .25 MAC Airfoil Section Root Tip EXPOSED DATA Area Span, (equivalent) Aspect Ratio Taper Ratio Chords Root Tip Solution 250 ft. 250 ft. 250 ft. 250 ft. 240 in. 1.6 1.6 1.6 1.6 1.6 1.6 1.6 1		_	_
## MAC	Tip, (equivalent)		
W.P. of .25 MAC B.L. of .25 MAC Airfoil Section Root Tip EXPOSED DATA Area Span, (equivalent) Aspect Ratio Taper Ratio Chords Root Tip Tip Solution Assoct Root Tip Tip Solution Tip Tip Solution Tip Taper Ratio Chords Root Tip	MAC	-	-
B.L. of .25 MAC Airfoil Section Root Tip EXPOSED DATA Area Span, (equivalent) Aspect Ratio Taper Ratio Chords Root Tip Tip Span Root Taper Ratio Taper Ratio Taper Ratio Taper Ratio Tip		•••	
Airfoil Section Root Tip EXPOSED DATA Area Span, (equivalent) Aspect Ratio Taper Ratio Chords Root Tip Root Tip Swedge (60/40) Swedge (60/			
Root 5 wedge (60/40) 5 w		-	-
Tip 5 wedge (60/40) 5 we	· - · ·	P - (Calla)	-0 · /(a/)·a
EXPOSED DATA Area 250 ft. ² 250 ft. ² Span, (equivalent) 240 in. 240 in. Aspect Ratio 1.6 1.6 Taper Ratio 0.35 0.35 Chords 230 in. 0.920 in. Tip 80 in. 0.320 in.		5 wedge (60/40)	5 wedge (60/40
Span, (equivalent) 240 in. 240 in. Aspect Ratio 1.6 1.6 Taper Ratio 0.35 0.35 Chords 230 in. 0.920 in. Tip 80 in. 0.320 in.	EXPOSED DATA	5 wedge (60/40)	5 <u>weage</u> (60/40
Aspect Ratio 1.6 1.6 Taper Ratio 0.35 0.35 Chords Root 230 in. 0.920 in. Tip 80 in. 0.320 in.		250 ft. ²	250 ft. ²
Taper Ratio 0.35 0.35 Chords 230 in. 0.920 in. Tip 80 in. 0.320 in.			
Chords Root 230 in. 0.920 in. Tip 80 in. 0.320 in.			
Root 230 in. 0.920 in. Tip 80 in. 0.320 in.		. 0.35	0.35
Tip <u>80 in.</u> <u>0.320 in.</u>		020 in	0 020 in
17DU	MAC		
Fus. Sta. of .25 MAC			**
W.P. of .25 MAC	W.P. of .25 MAC		
B.L. of .25 MAC	B.L. of .25 MAC	<u> </u>	=

TABLE IV (CONTINUED)

MODEL COMPONENT: BODY - R1	<u> </u>	:
GENERAL DESCRIPTION: Abort SRM pods. Co.	ne cylinder with a	22.50 half
angle nose cone. Rocket nozzle is a 22.5°	cone. Nose radio	us is .034 in.
model scale and 8.5 in. full scale.		
•		•
DRAWING NUMBER		
DIMENSION:	FULL SCALE	MODEL SCALE
Length	342 in.	1.368 in.
Max Width	62 in.	.248 iņ.
Max Depth	<u>-</u>	· •
Fineness Ratio	5.52	5.52

.0515 in.²

Area

Max Cross-Sectional

Planform

Wetted

Base

1.504 in.²

652.95 ft.

Base

TABLE IV (CONCLUDED)

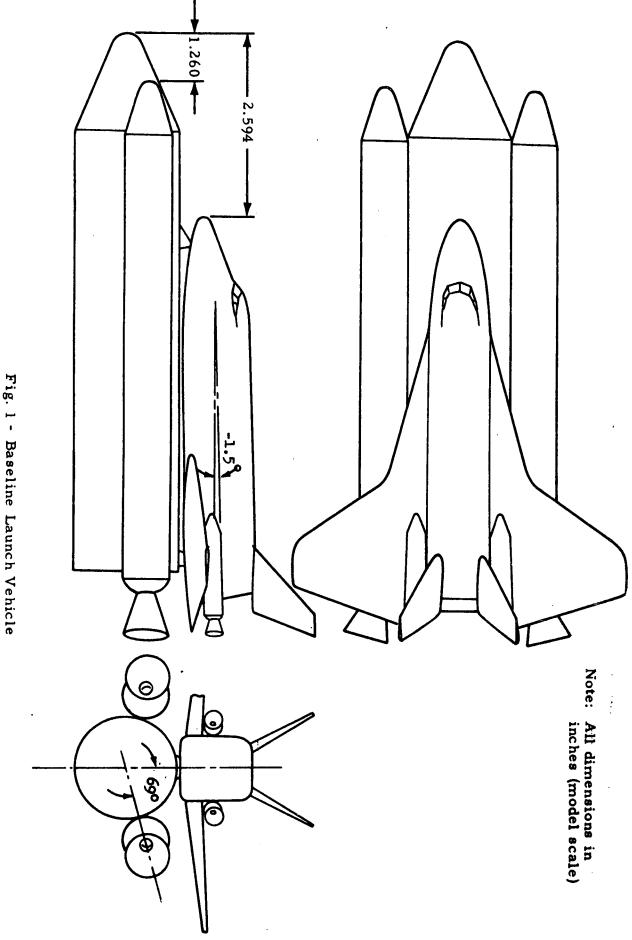
MODEL COMPONENT: BODY - S1		
GENERAL DESCRIPTION: Solid Rocket Motor		
DRAWING NUMBER		
DIMENSION:	FULL SCALE	MODEL SCALE
Length	1743 in.	6.972 in.
Max Width	156 in.	0.624 in.
Max Depth	<u>156 in.</u>	0.624 in.
Fineness Ratio	11.17	11.17
Area	•	
Max Cross-Sectional	132.5 ft. ²	0.306 in. ²
Planform		_
Wetted	_	
Base	132.5 ft. ²	0.306 in. ²

TABLE V.

INDEX OF MODEL FIGURES

FIGURE	DESCRIPTION	PAGE
1	Baseline Launch Vehicle	18
2	General Arrangement, Space Shuttle 049 Orbiter	19
3	156-Inch Solid Rocket Motor	20
4	Static Pressure Tap Positions	21
5	Typical MSFC 14 x 14 Inch Tunnel Installation for Pressure Testing of 049 Orbiter in Launch Configuration	22

TITLE	PARAMETER	VALUES	PLOT TYPE	CONDITIONS VARYING	PAGE
T101 Fuselage Pressures	-1.5	0	CP vs. X/L	α, Mn	1-14
	-1.5	0	CP vs. X/L	β, Mn	15-28
T101 R1 Fuselage Pressures	-1.5	0	CP vs. X/L	œ, Mn	29-36
	-1.5	0	CP vs. X/L	β, Mn	37-44
T101 R1S1 Fuselage Pressures	-1.5	210	CP vs. X/L	α, Mn	45-58
	-1.5	210	CP vs. X/L	β, Mn	59-72
01 Fuselage Pressures	. 1	1	CP vs. X/L	α, Mn	73-86
	ı		CP vs. X/L	β, Mn	87-100
		ı	CP vs. X/L	α, Mn	101-102
TlO1 Upper/Lower Wing Pressures	-1.5	1	CP vs. X/C	α, Y/B, Mn	103-116
	-1.5	1	CP vs. X/C	β, Υ/Β, Mn	117-130
T101 R1 Upper/Lower Wing Pressures	-1.5	ı	CP vs. X/C	α, Y/B, Mn	131-138
	-1.5	I	CP vs. X/C	β, Υ/B, Mn	139-146
T101 R1S1 Upper/Lower Wing Pressures	-1.5	210	CP vs. X/C	α, Υ/B, Mn	147-160
	-1.5	510	CP vs. X/C	β, Υ/B, Mn	161-174
Ol Upper/Lower Wing Pressures		. ,	CP vs. X/C	α, Υ/Β, Mn	175-188
	i		CP vs. X/C	β, Y/B, Mn	189-202
	1	ı	CP vs. X/C	α, Y/B, Mn	203-204



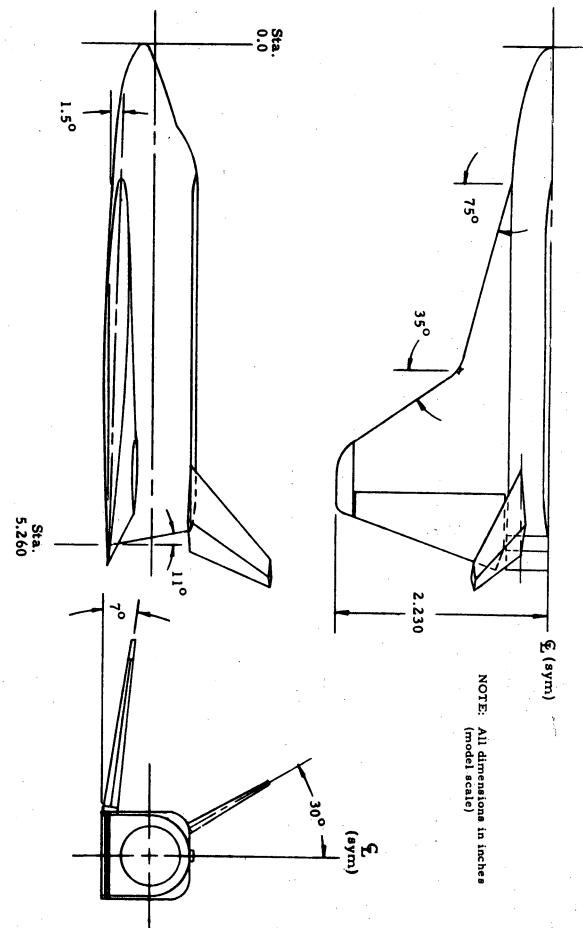
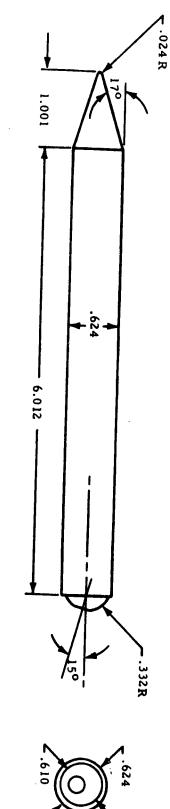


Fig. 2- General Arrangement, Space Shuttle 049 Orbiter

Note: All dimensions in inches (model scale)



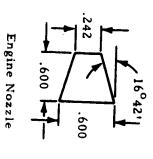


Fig. 3- 156-Inch Solid Rocket Motor

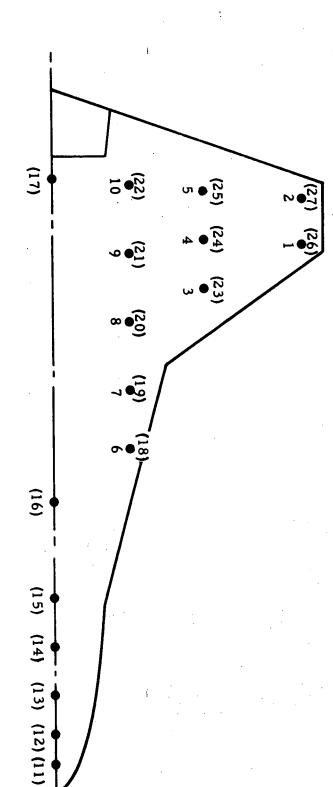


Fig. 4 - Static Pressure Tap Positions

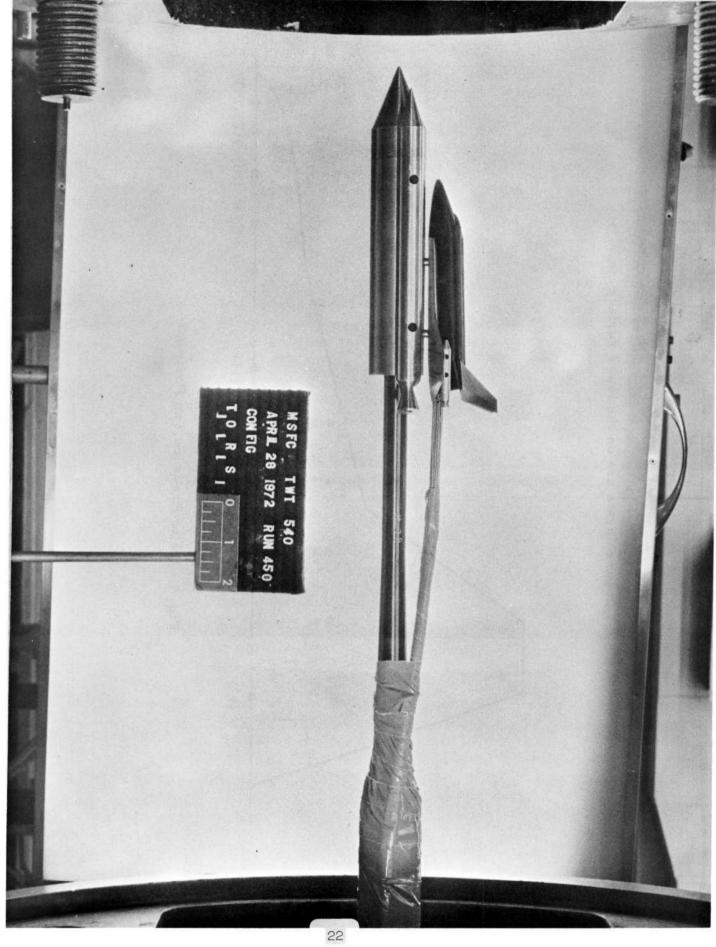
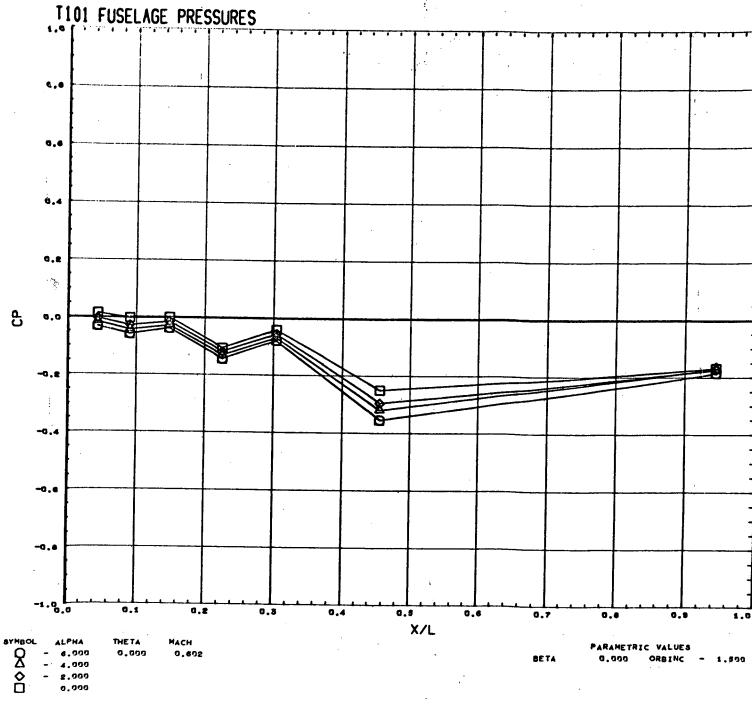


Figure 5. Typical MSFC 14x14-Inch Tunnel Installation for Pressure Testing of 049 Orbiter in the Launch Configuration

DATA FIGURES

Tabulations of the plotted data and corresponding source data are available from SADSAC Operations.

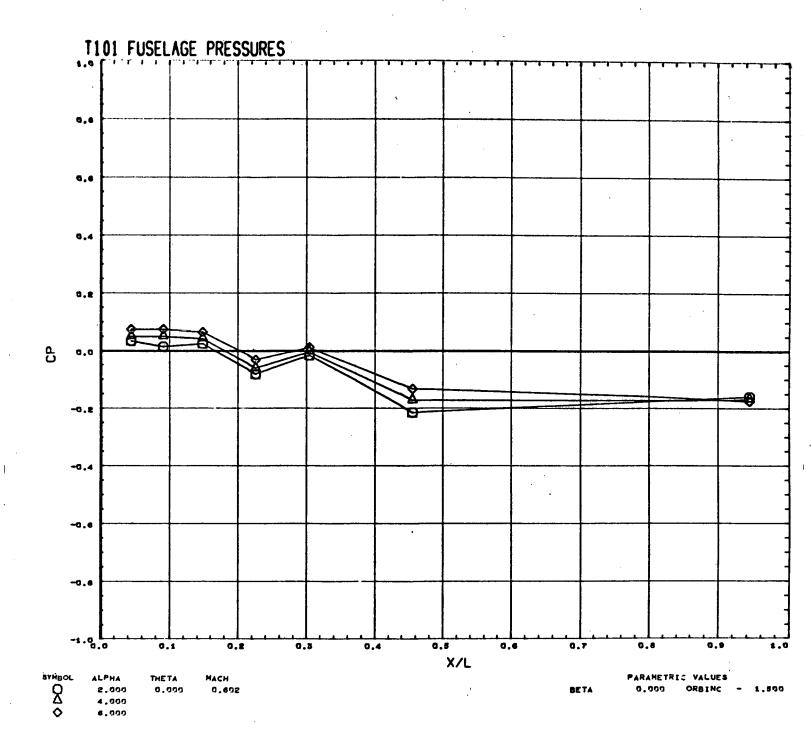


MSFC TWT 540 LAUNCH PRESSURES T101 (FUSELAGE) (A67001)

PAGE

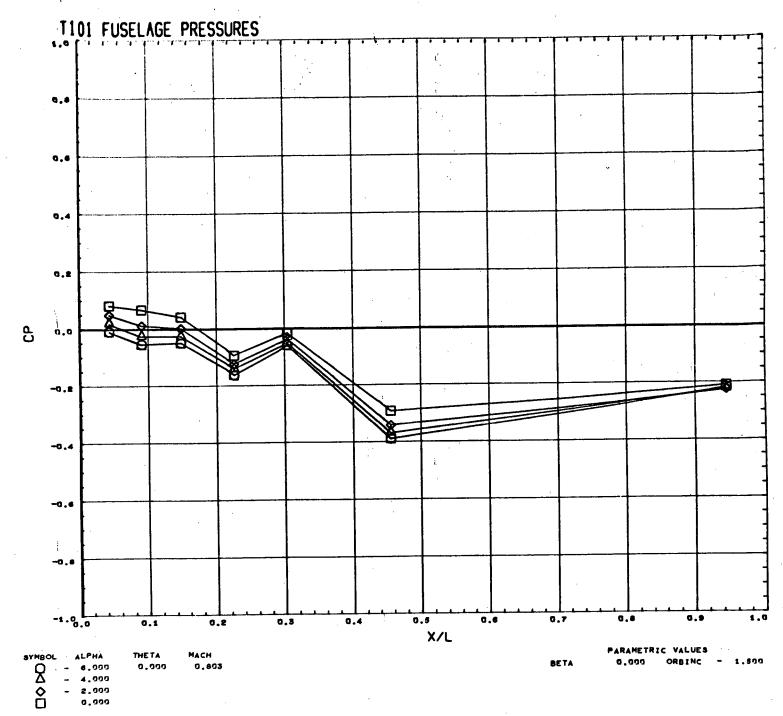
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C



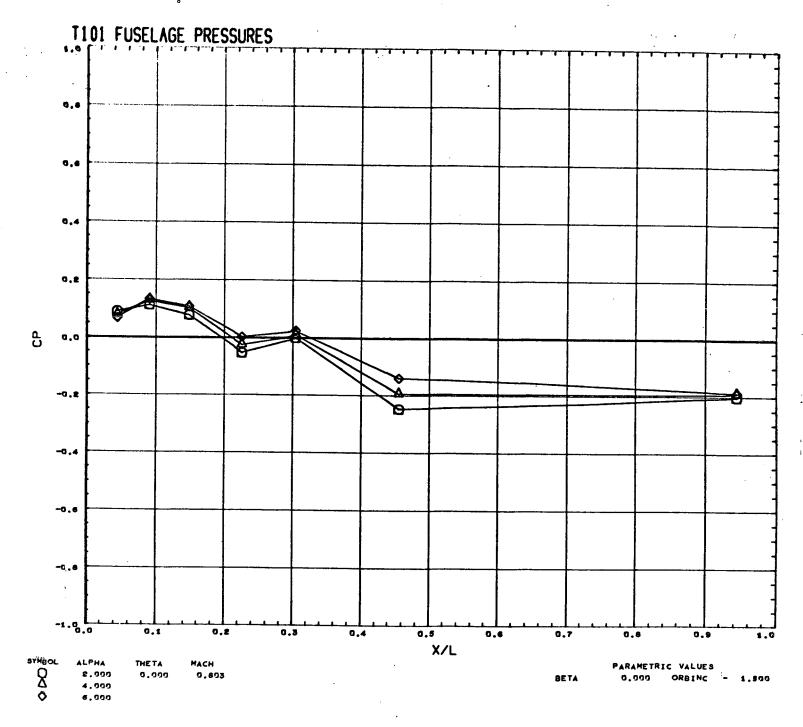
MSFC TWT 540 LAUNCH PRESSURES T101 (FUSELAGE) (A67001)

PAGE



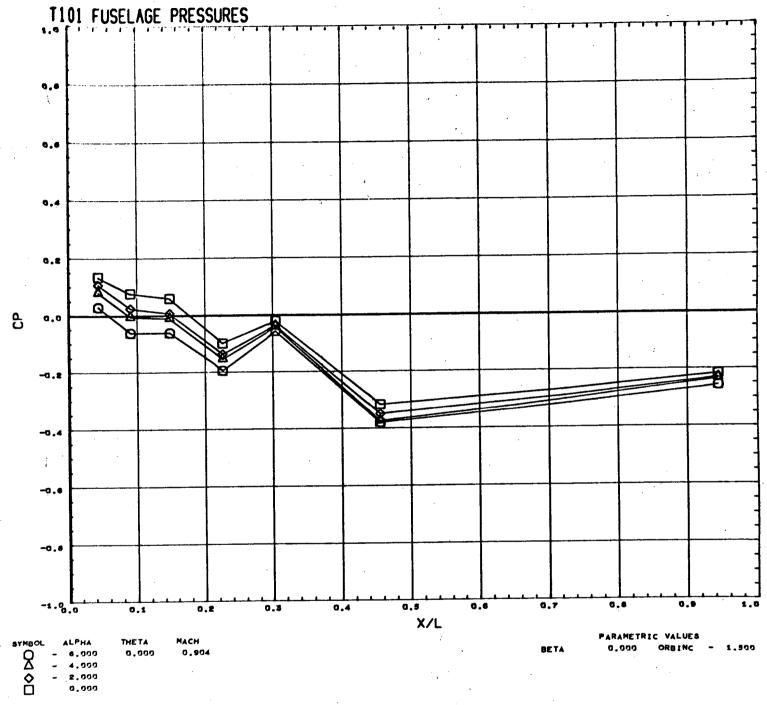
MSFC TWT 540 LAUNCH PRESSURES T101 (FUSELAGE) (A67001)

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MSFC TWT 540 LAUNCH PRESSURES TIO1 (FUSELAGE) (A67001)

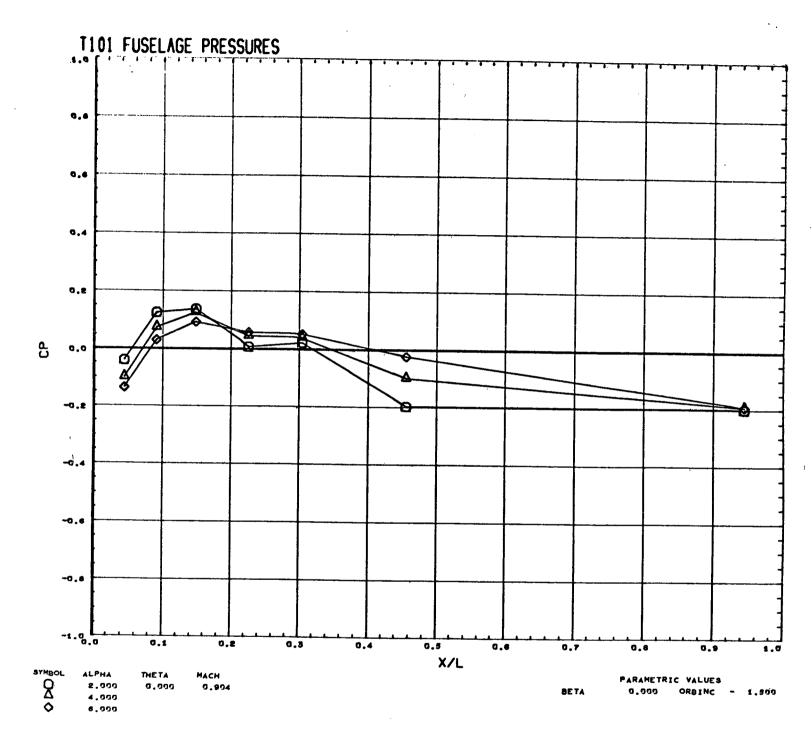
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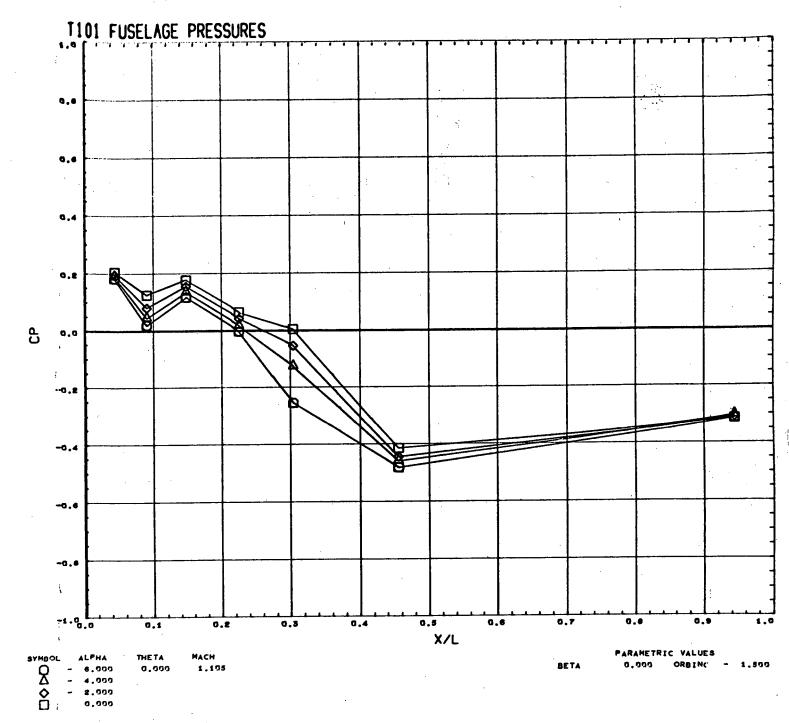
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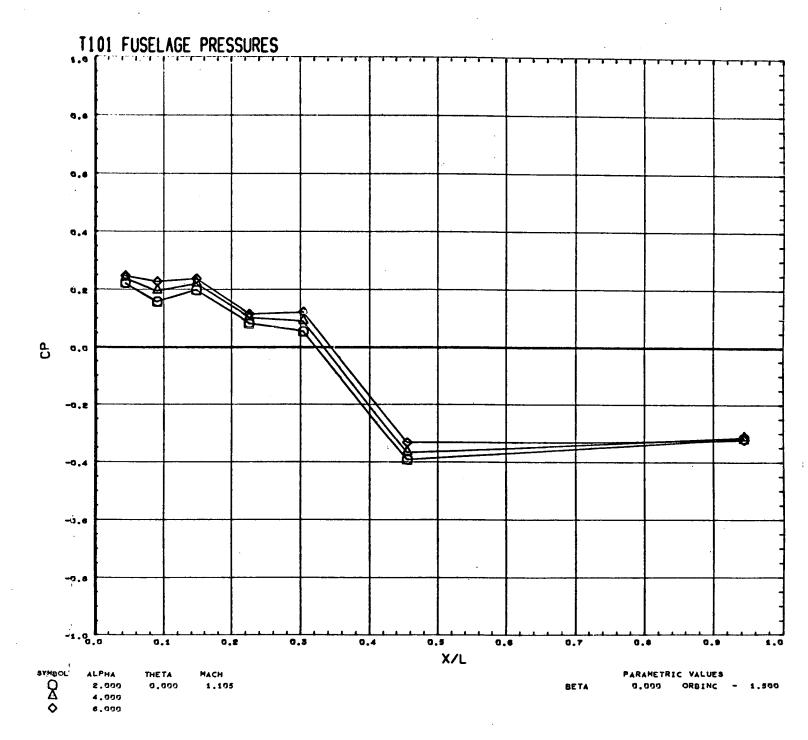
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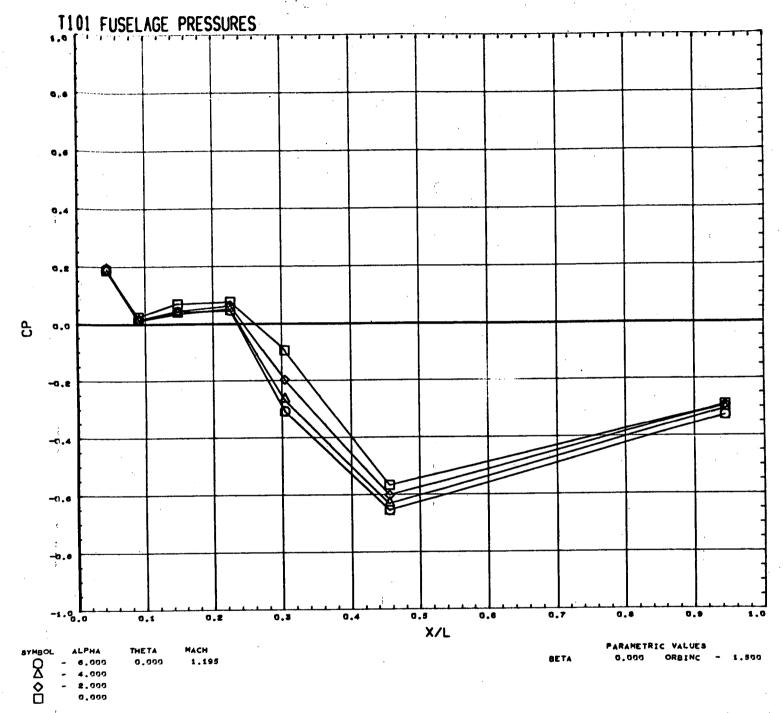
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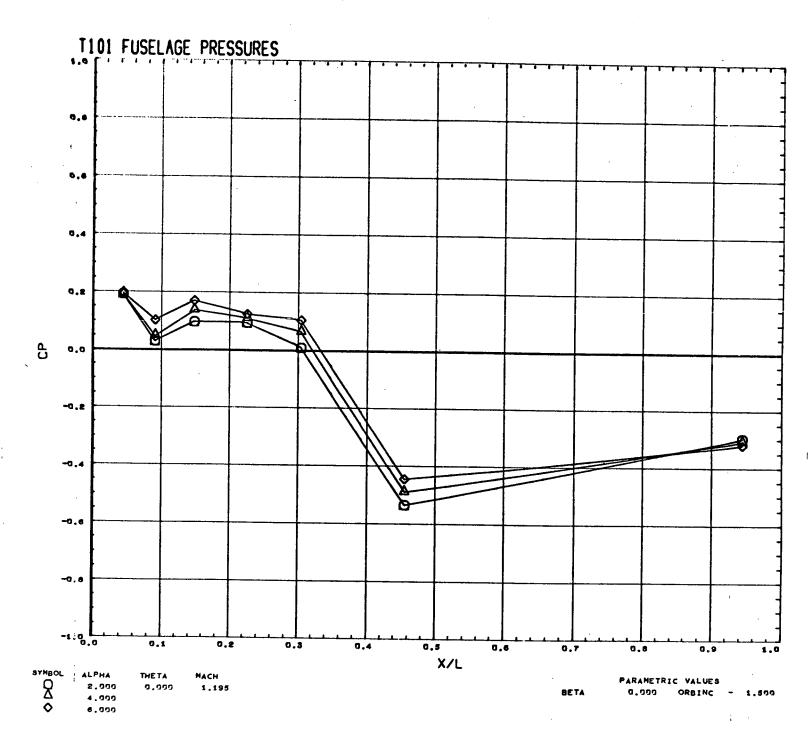
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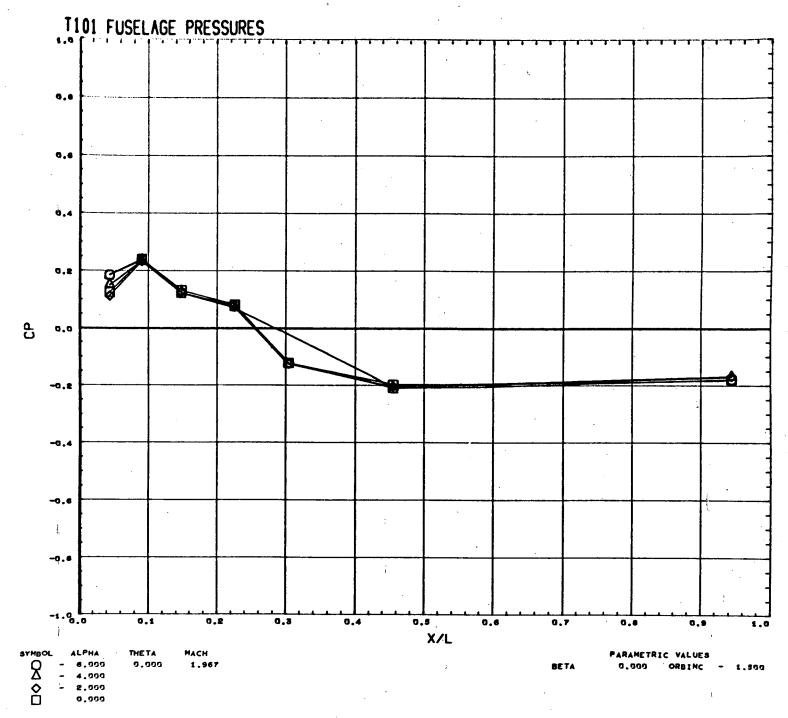
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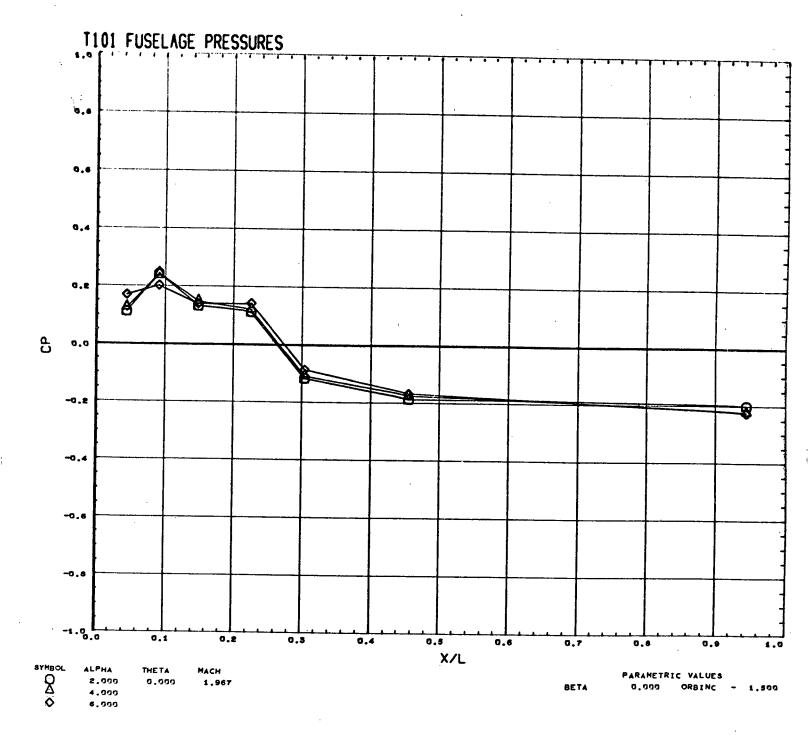
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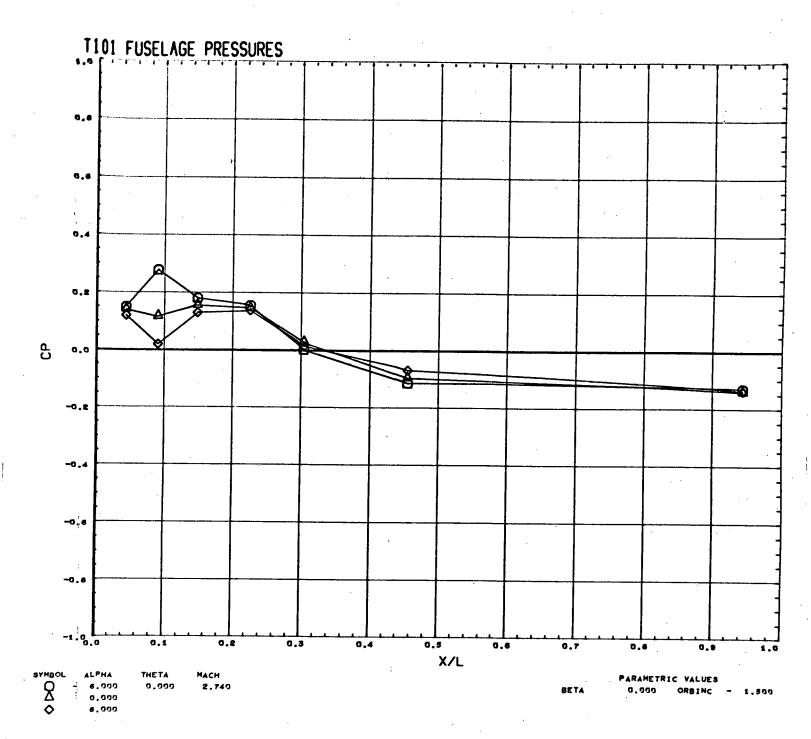
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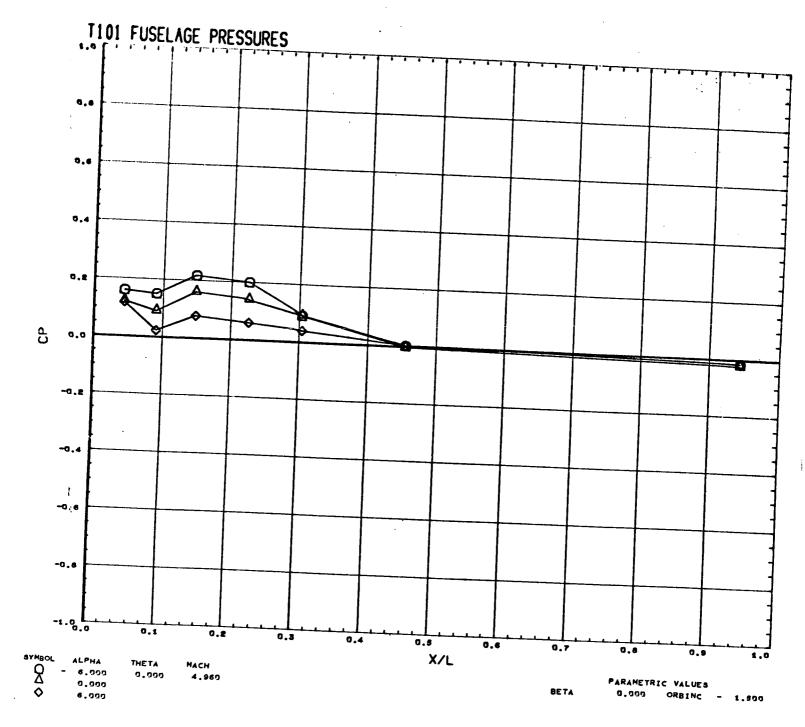
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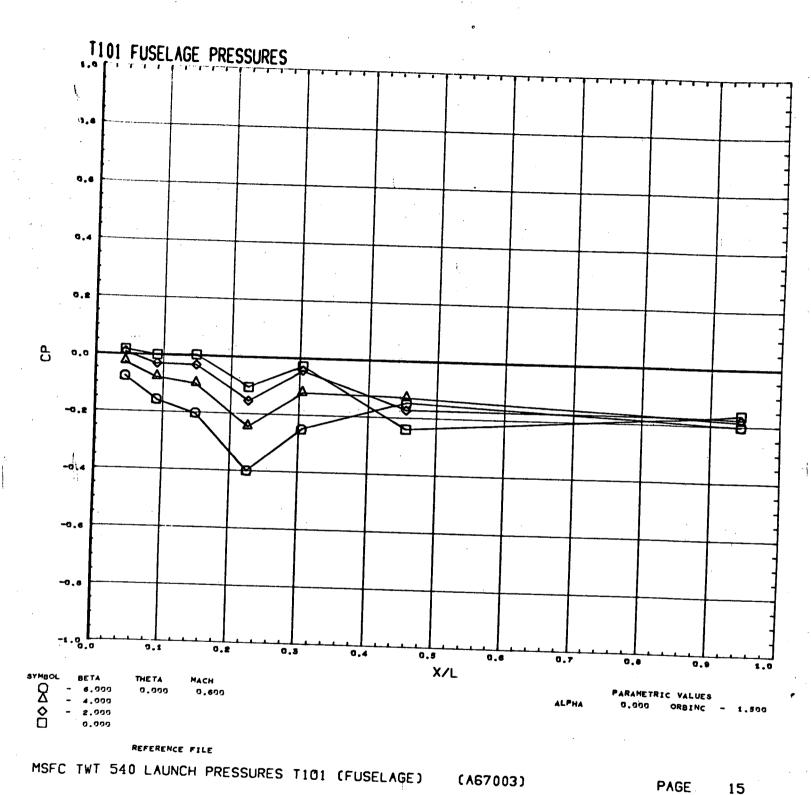
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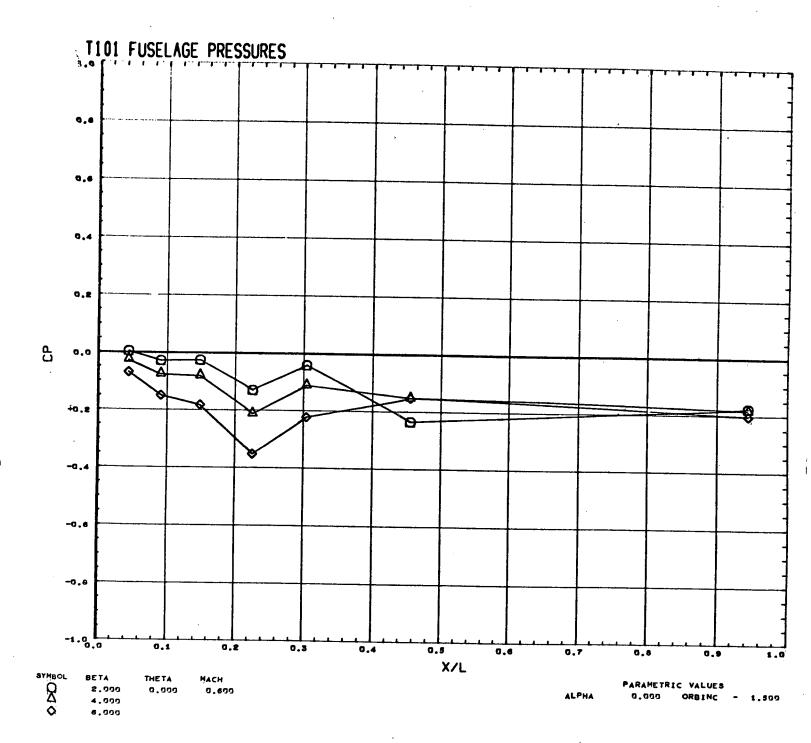


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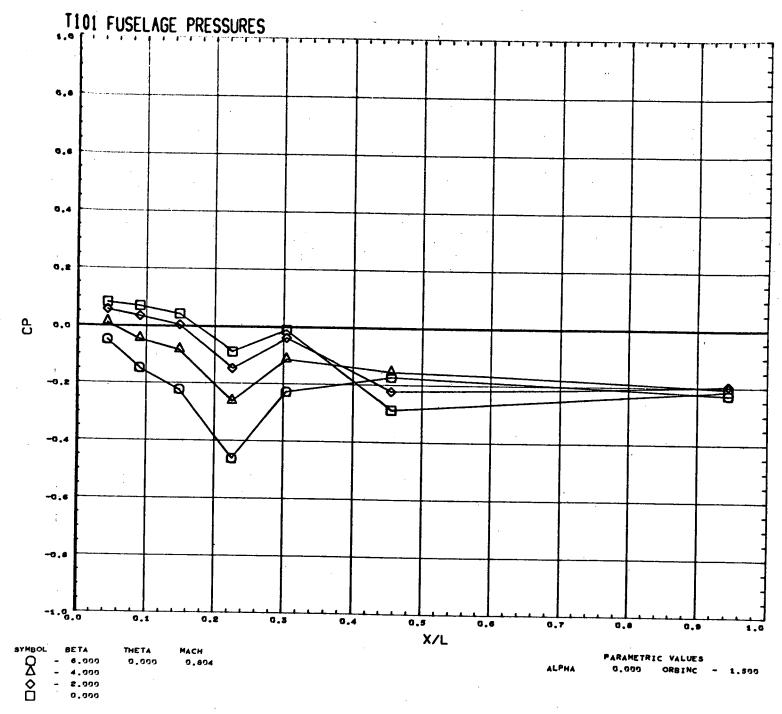


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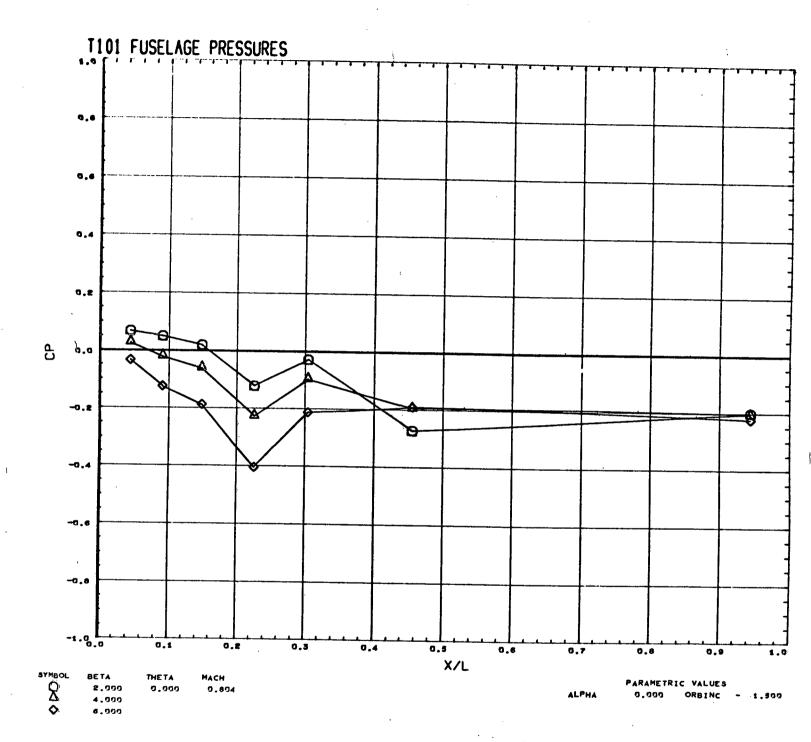
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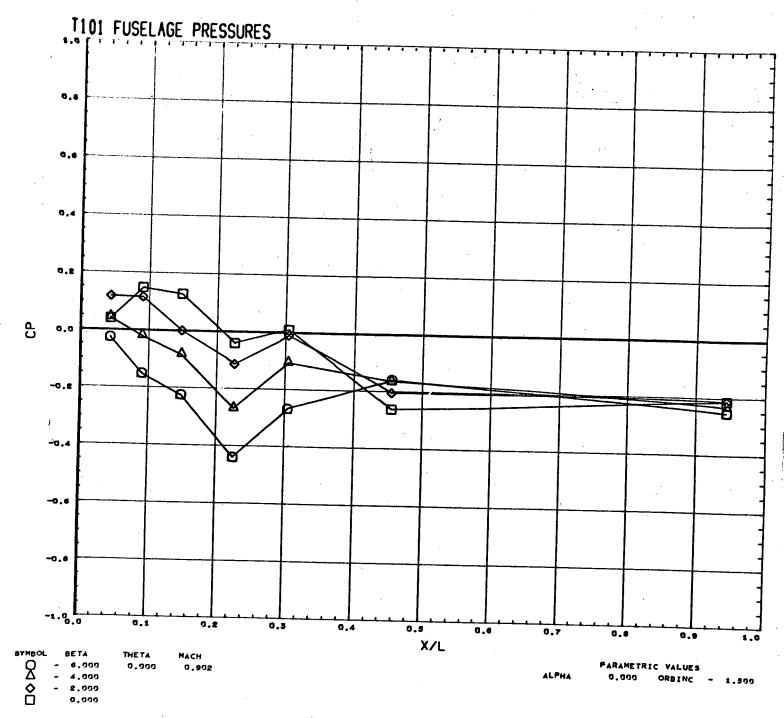
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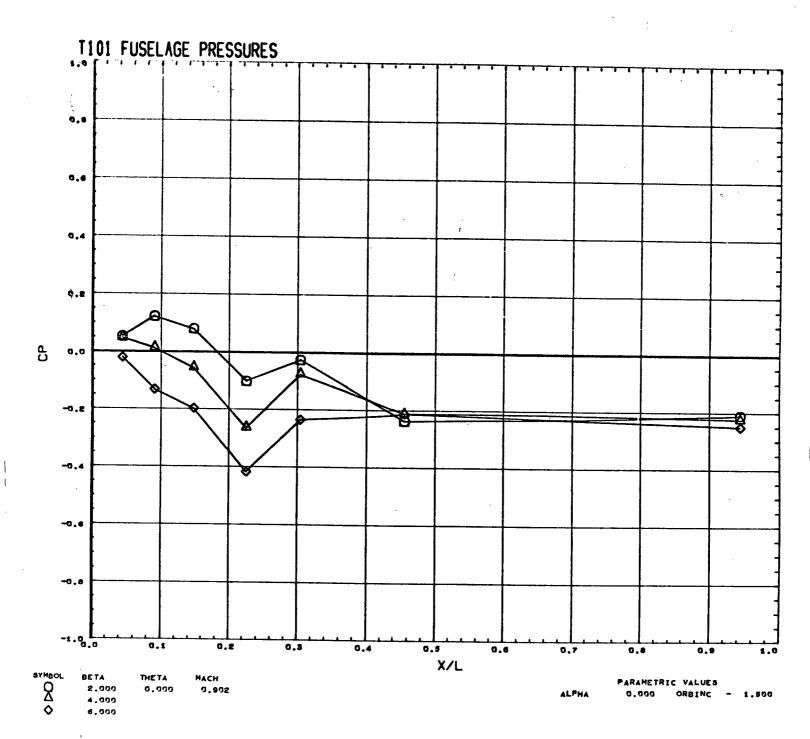
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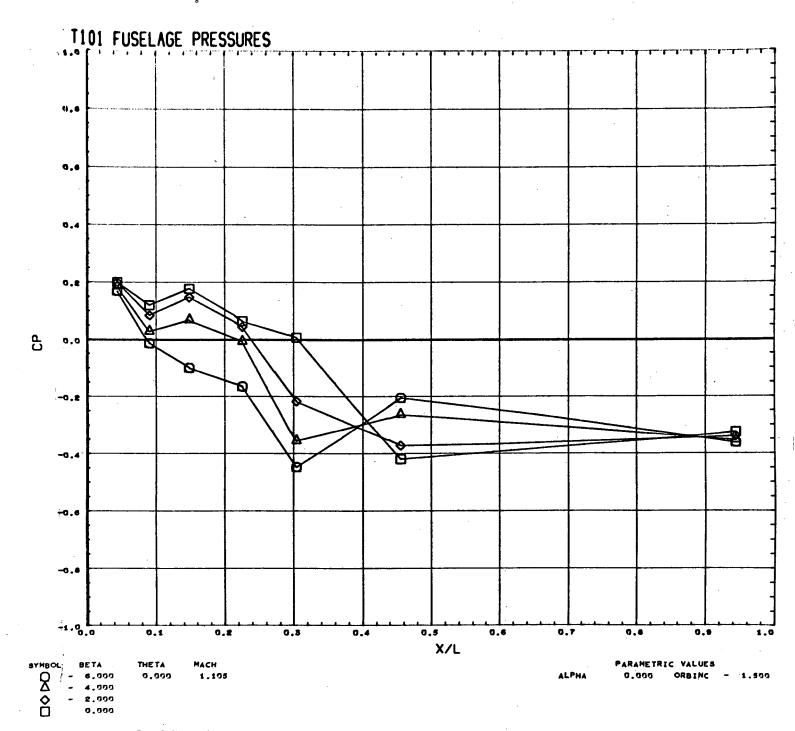
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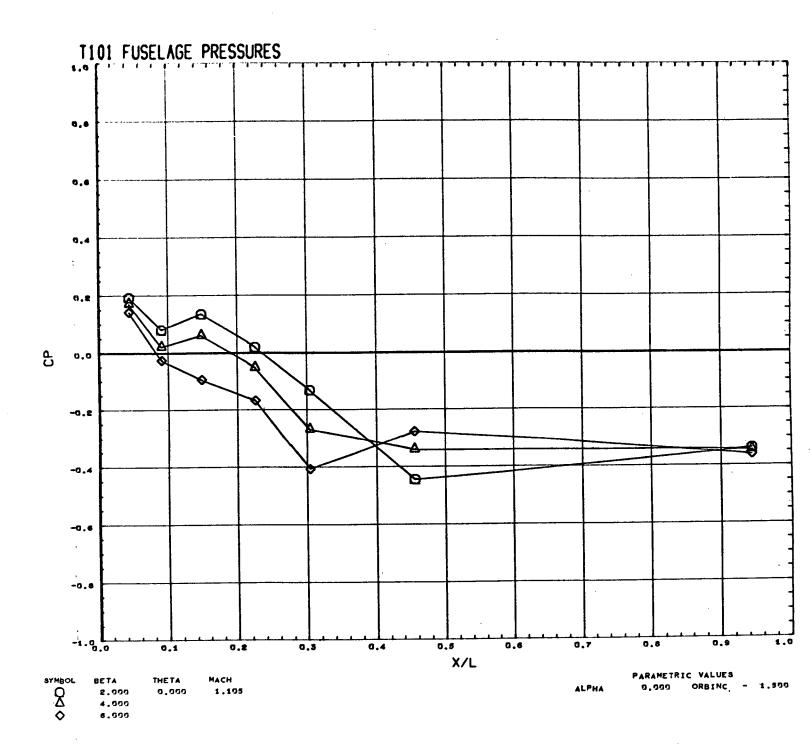
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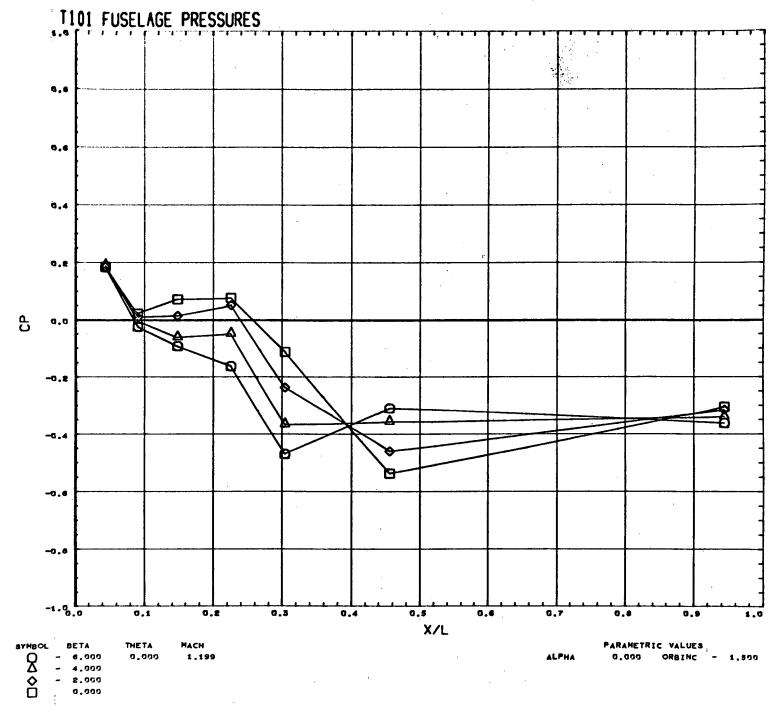


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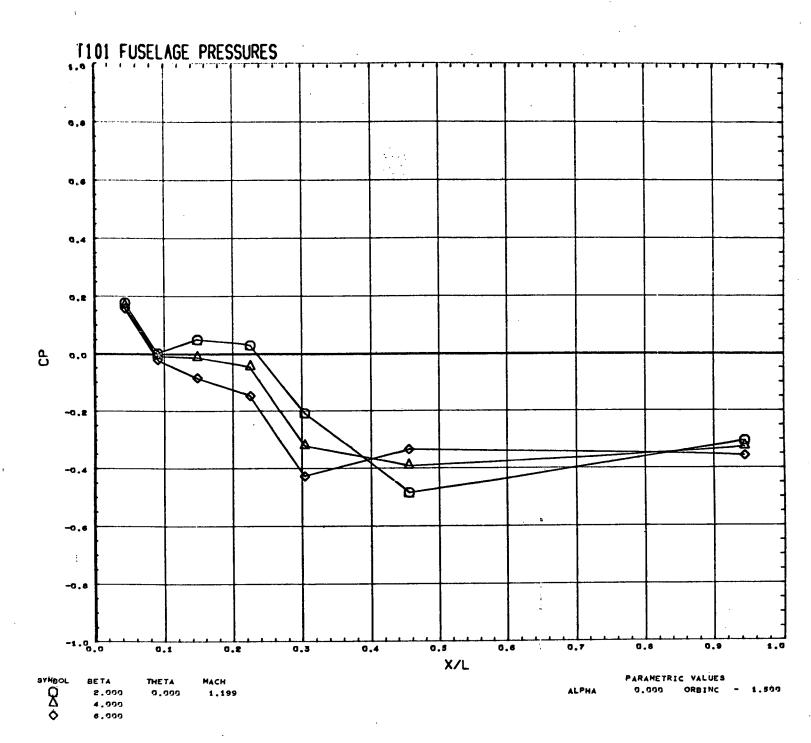
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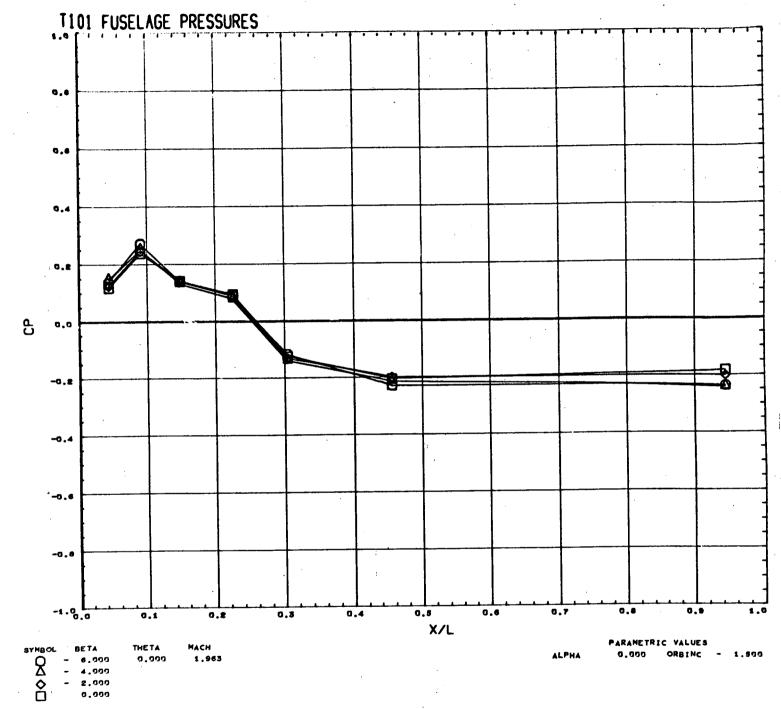
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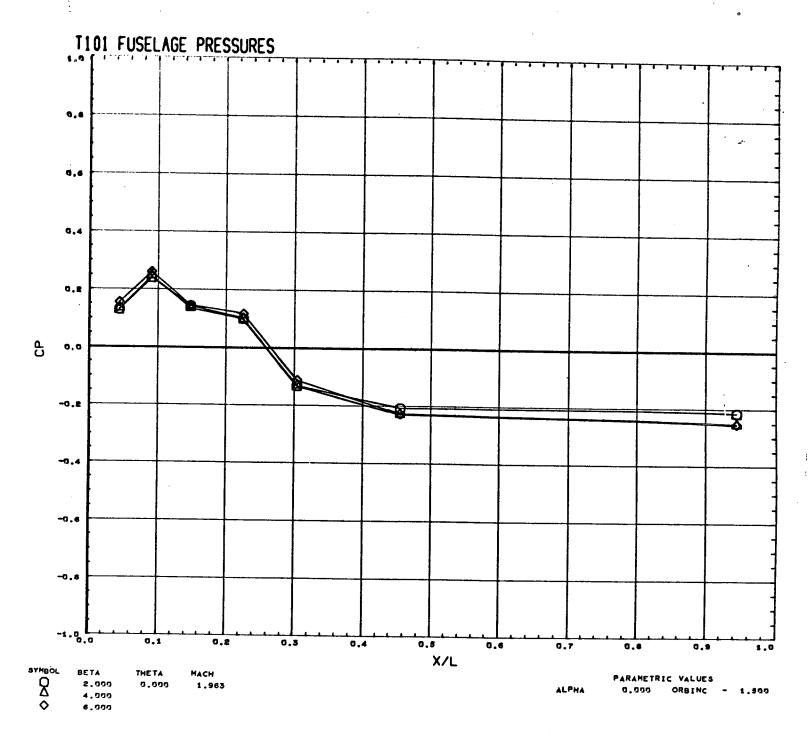
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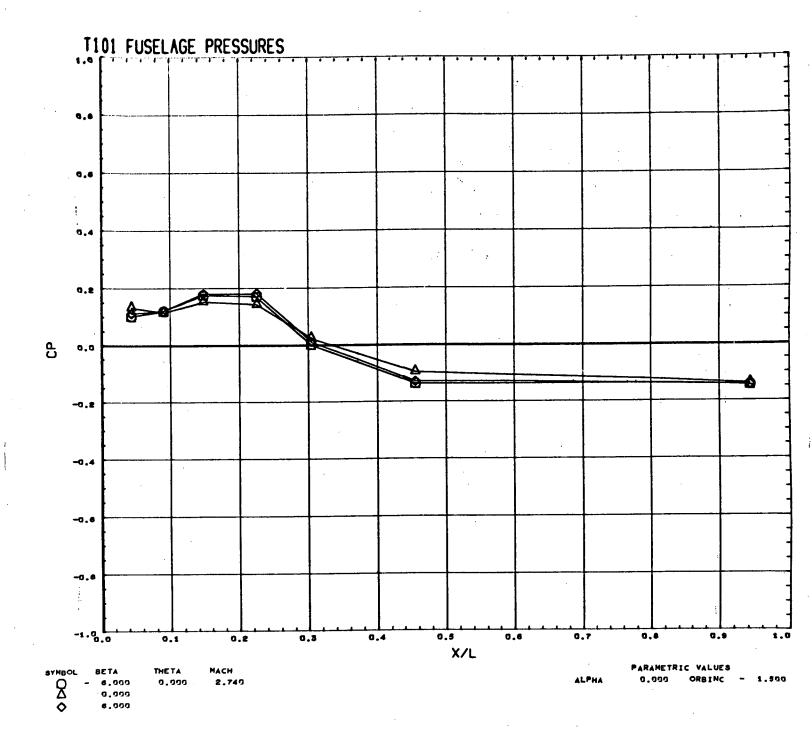
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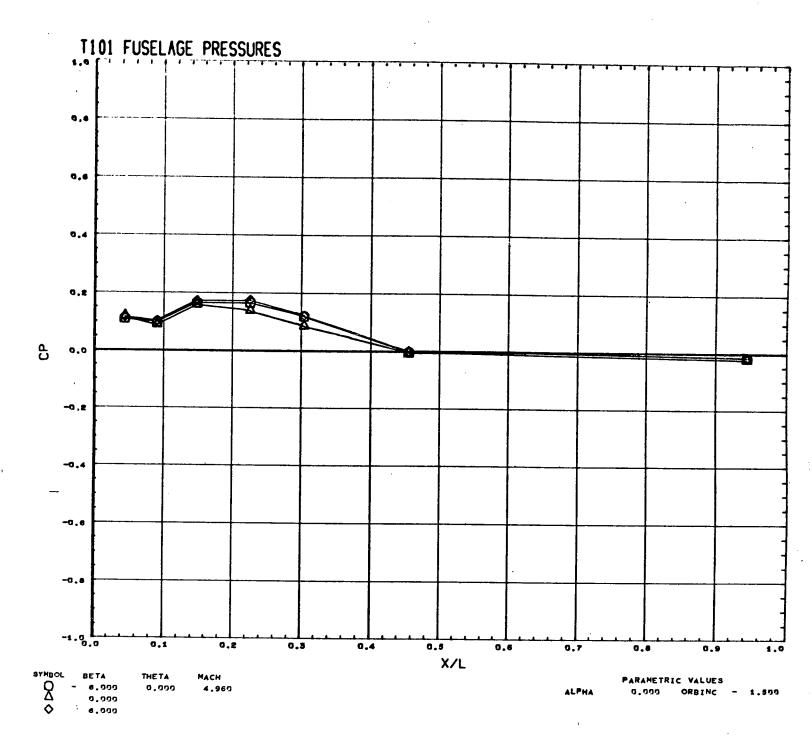
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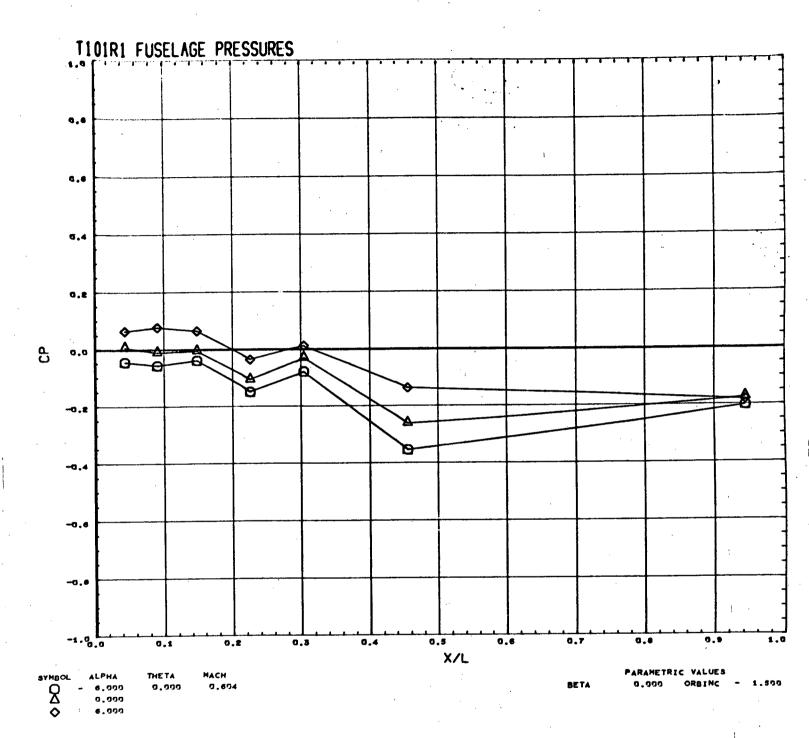
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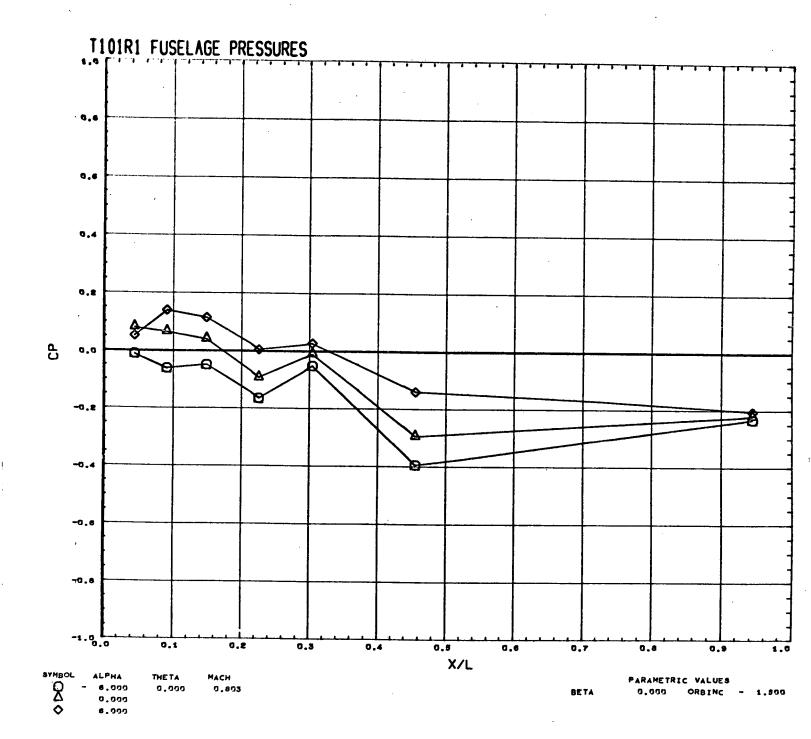
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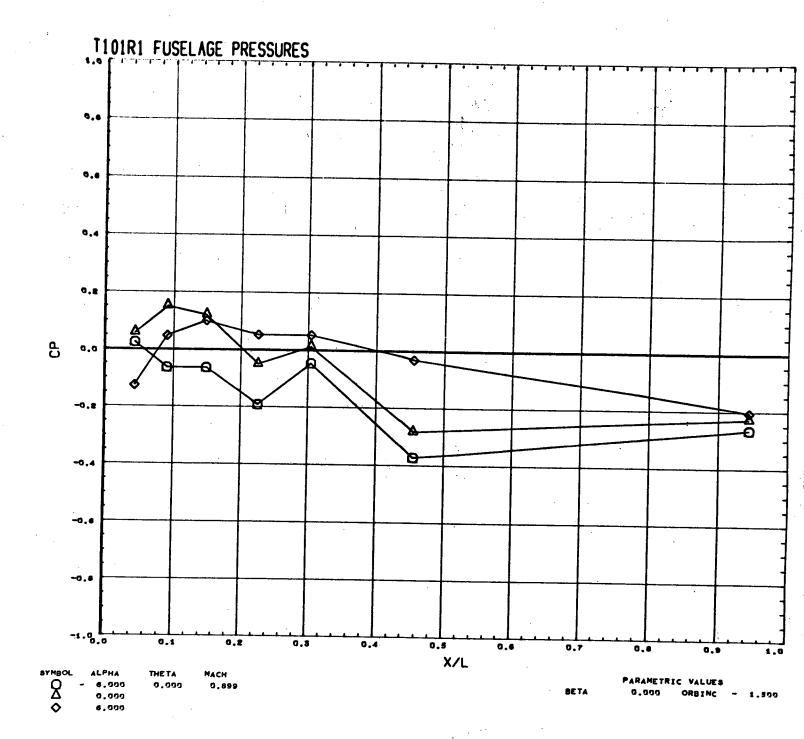
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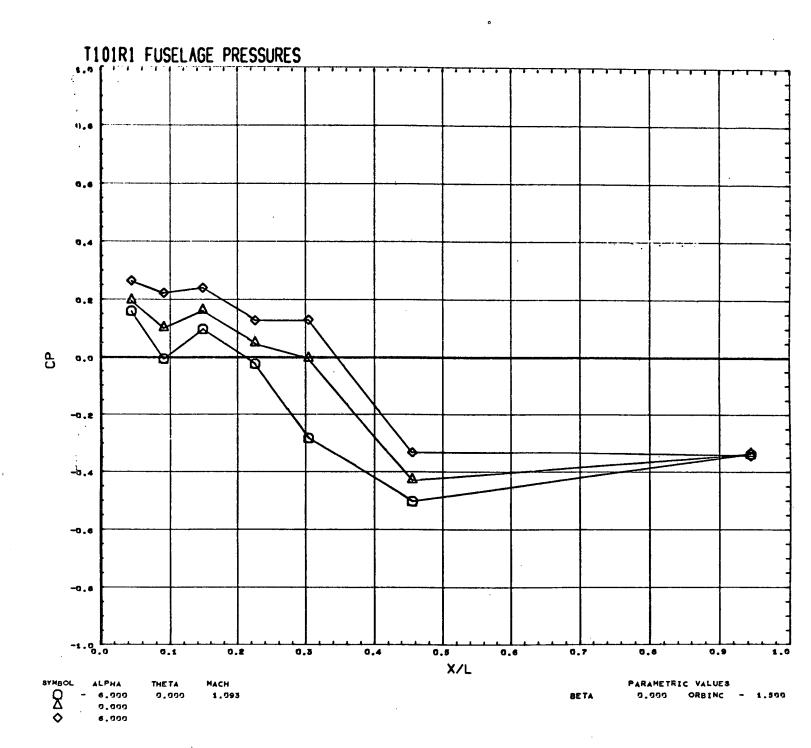
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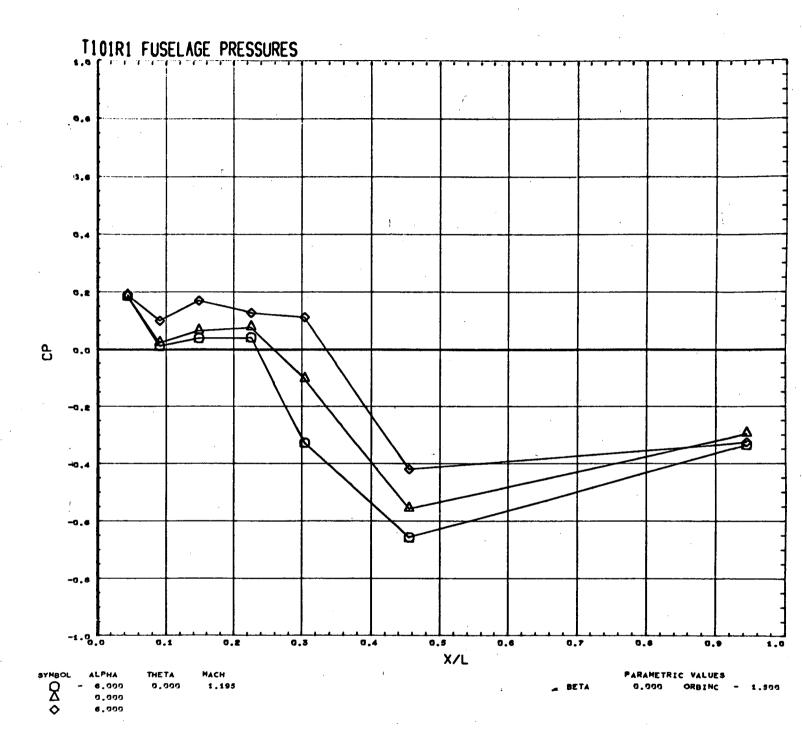
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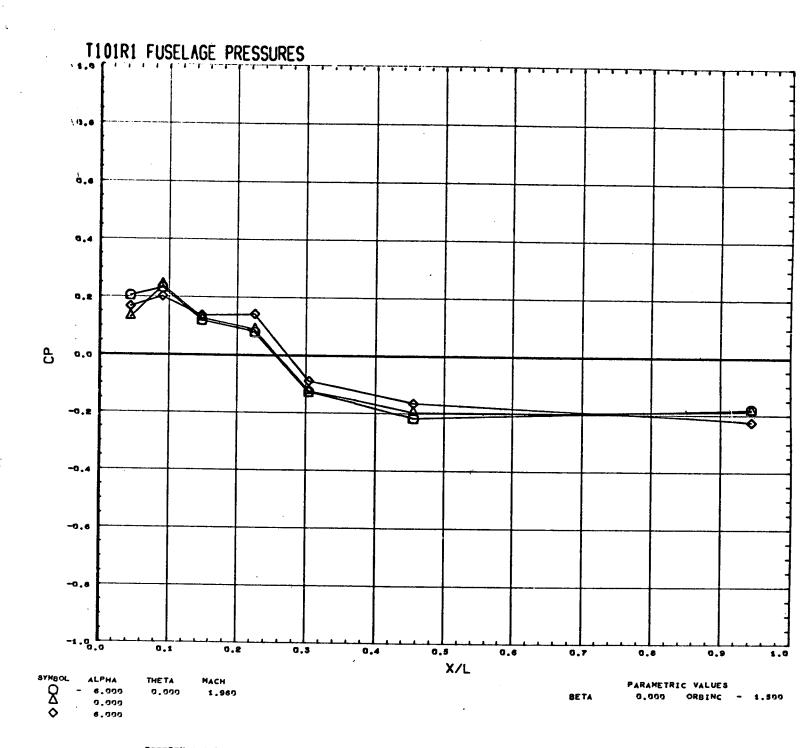
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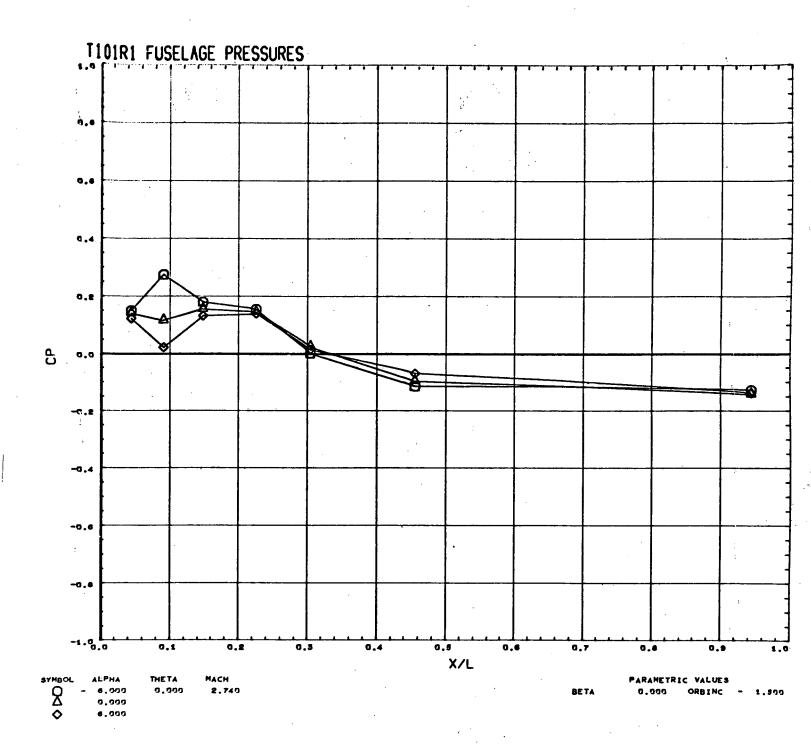
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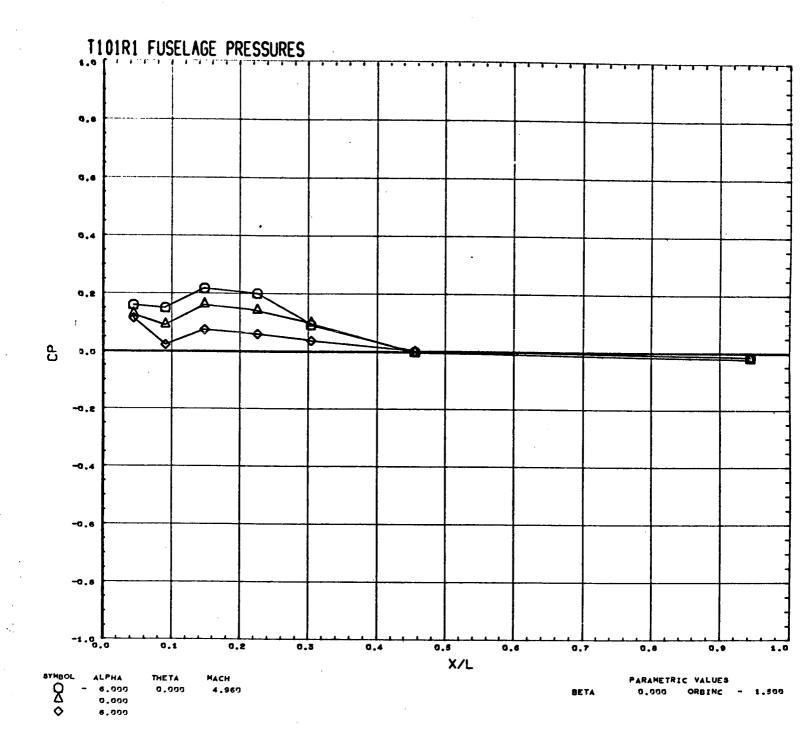
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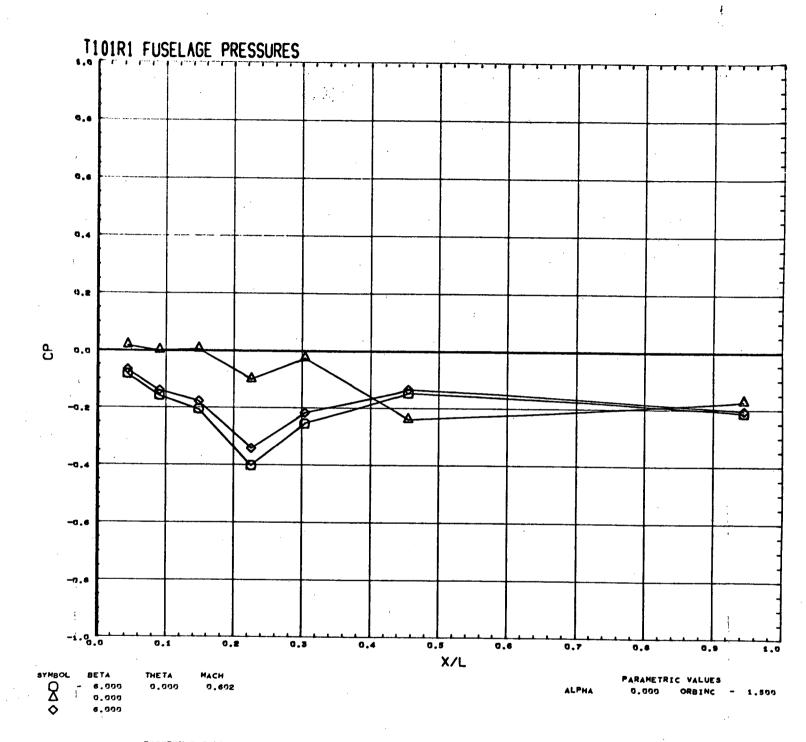
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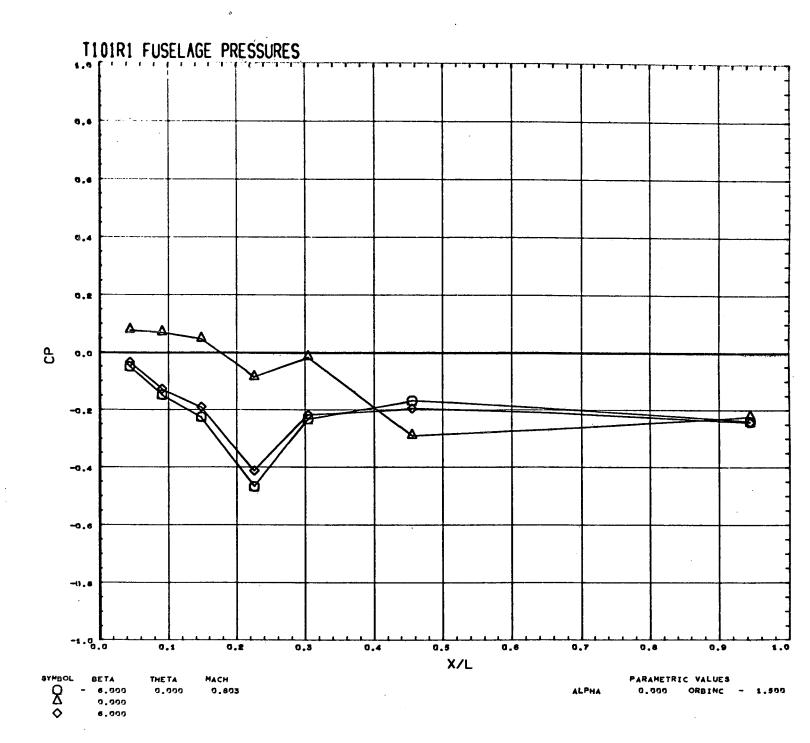
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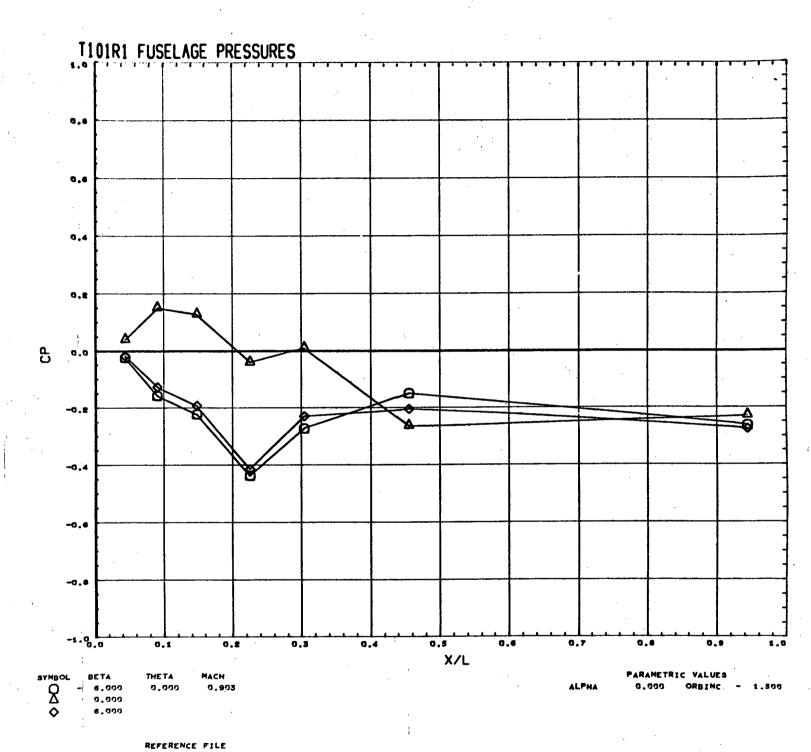
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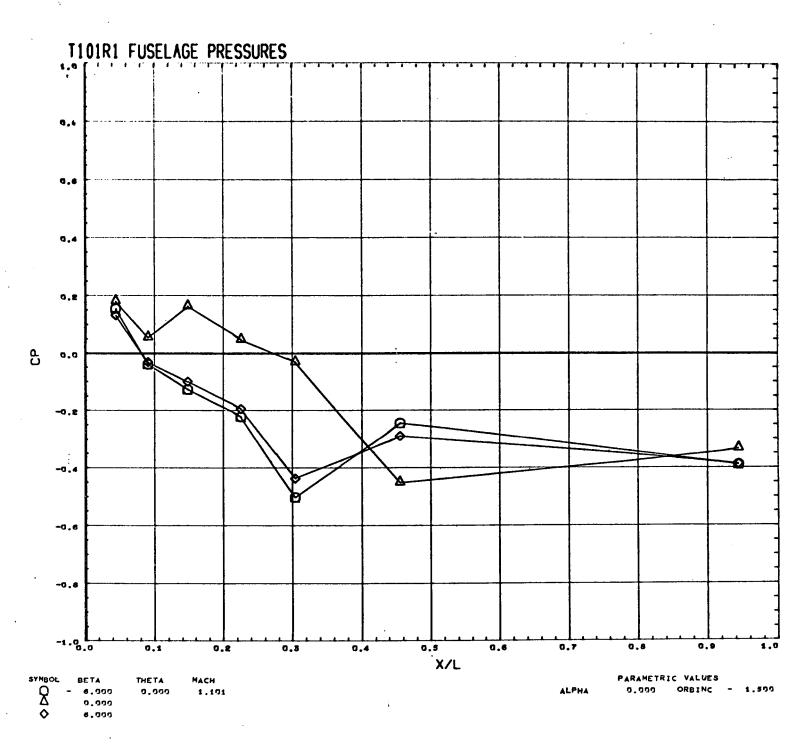


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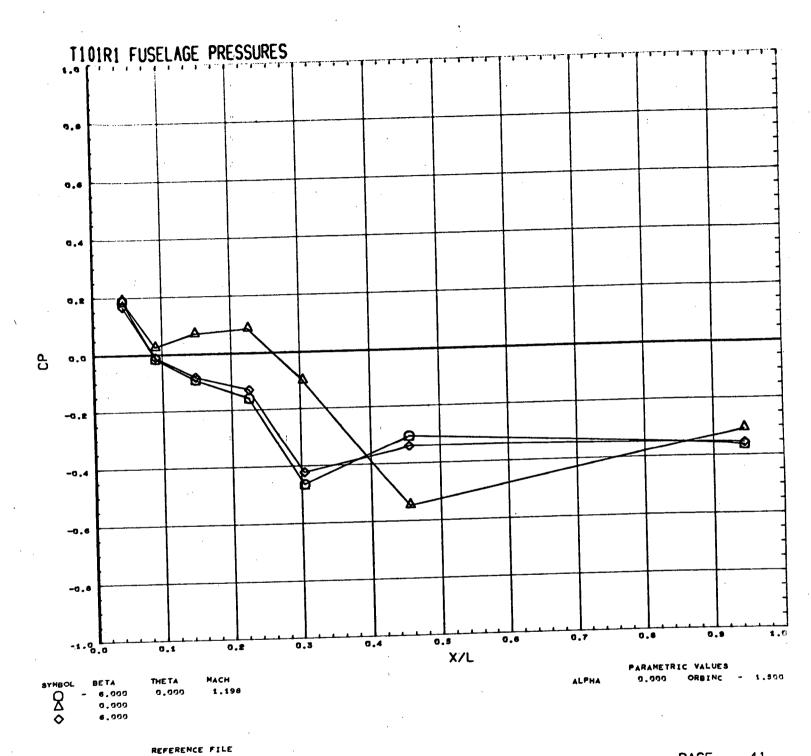


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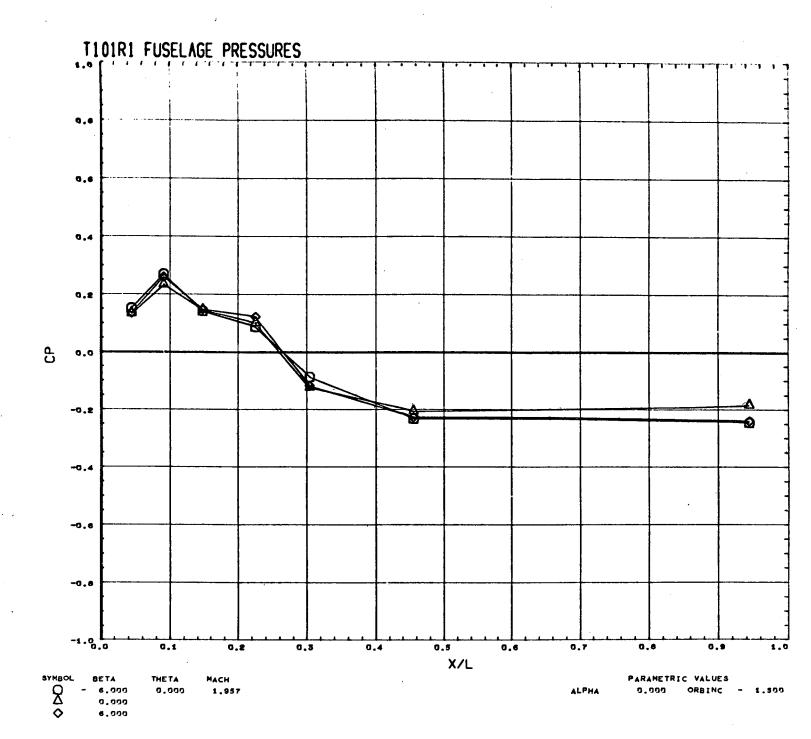
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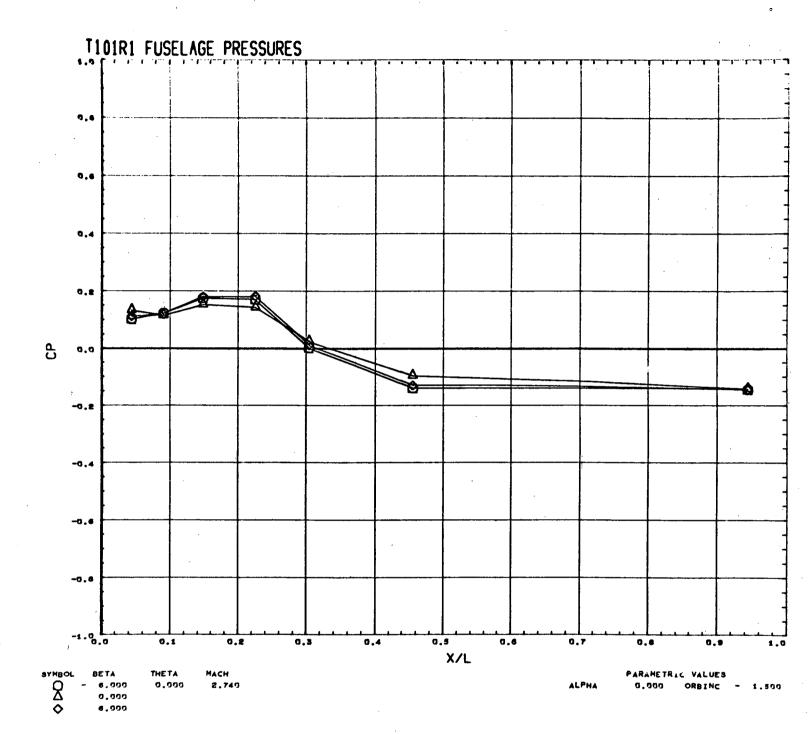
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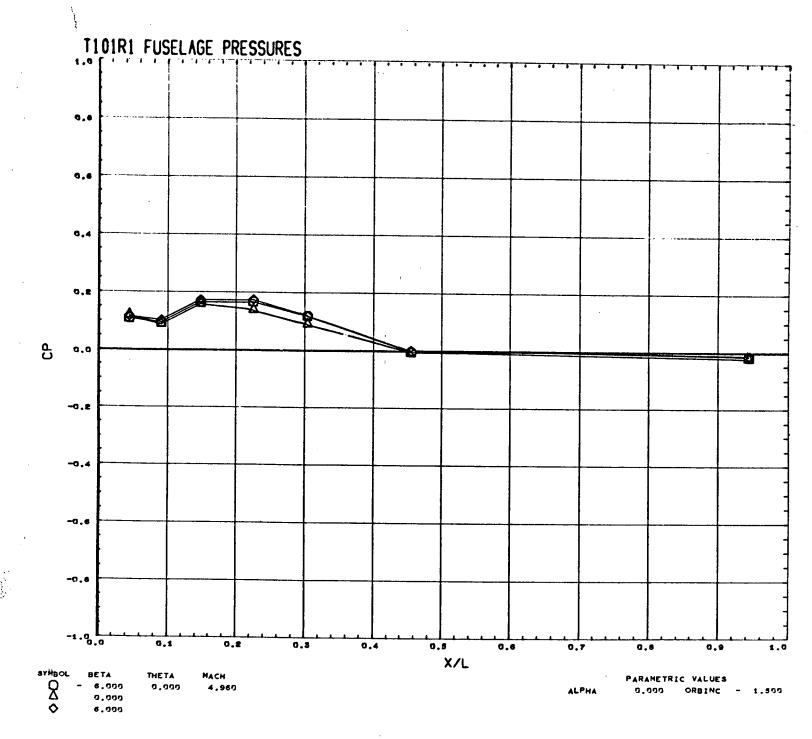
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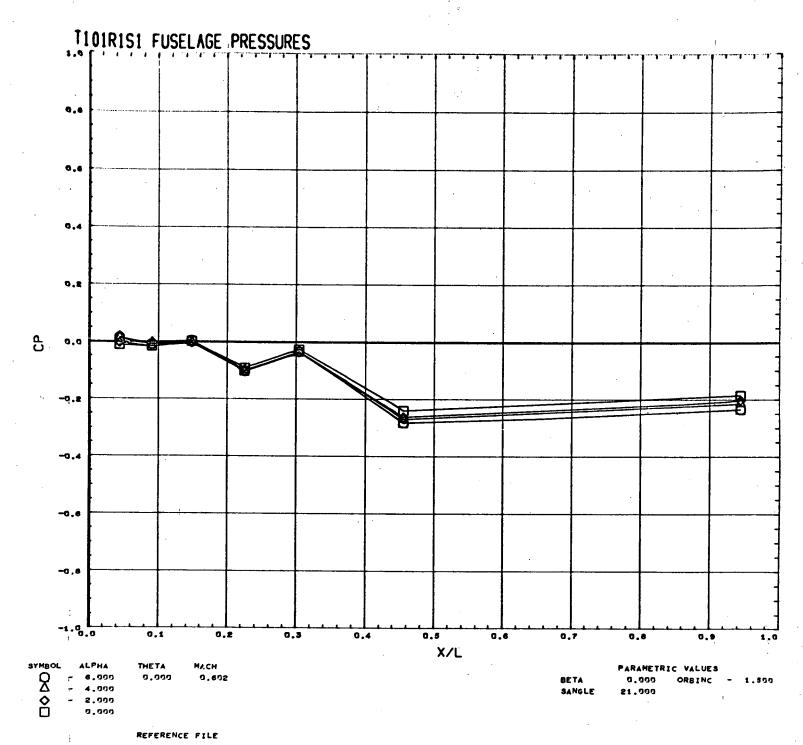
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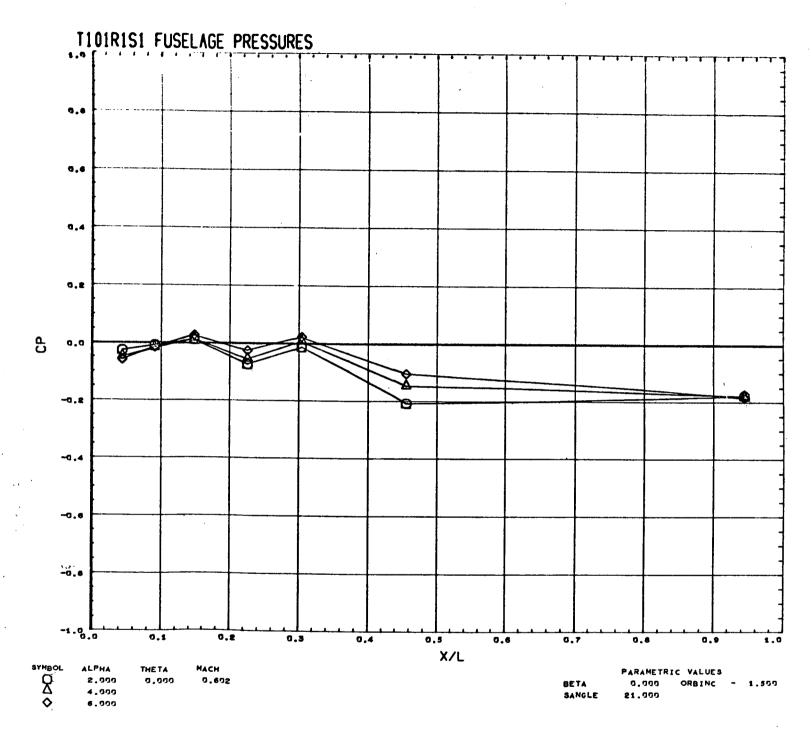
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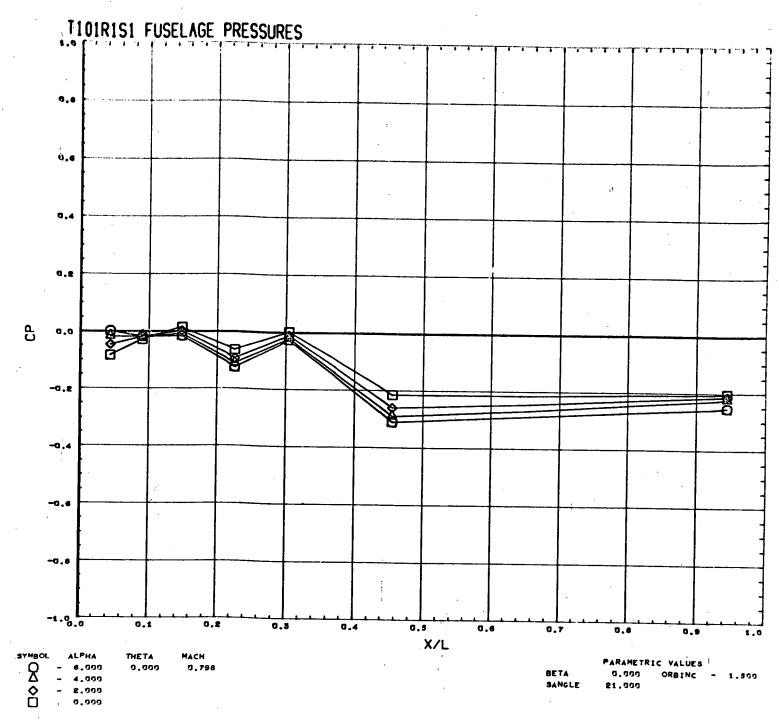
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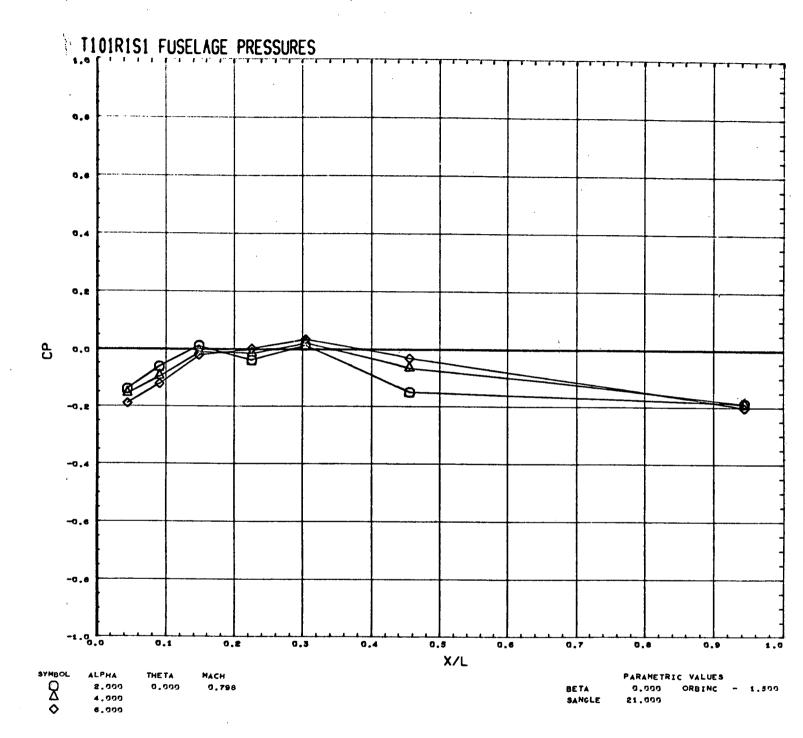
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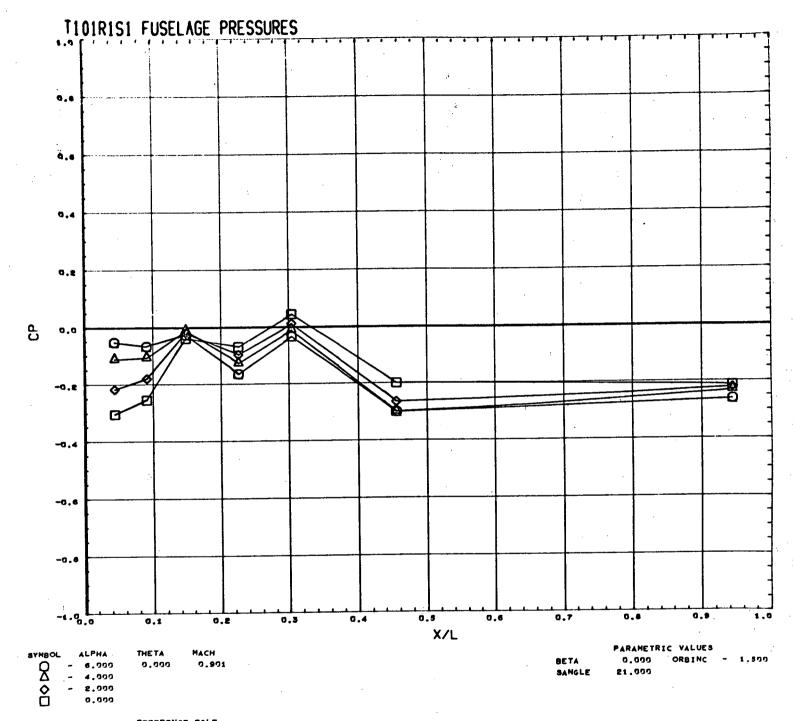
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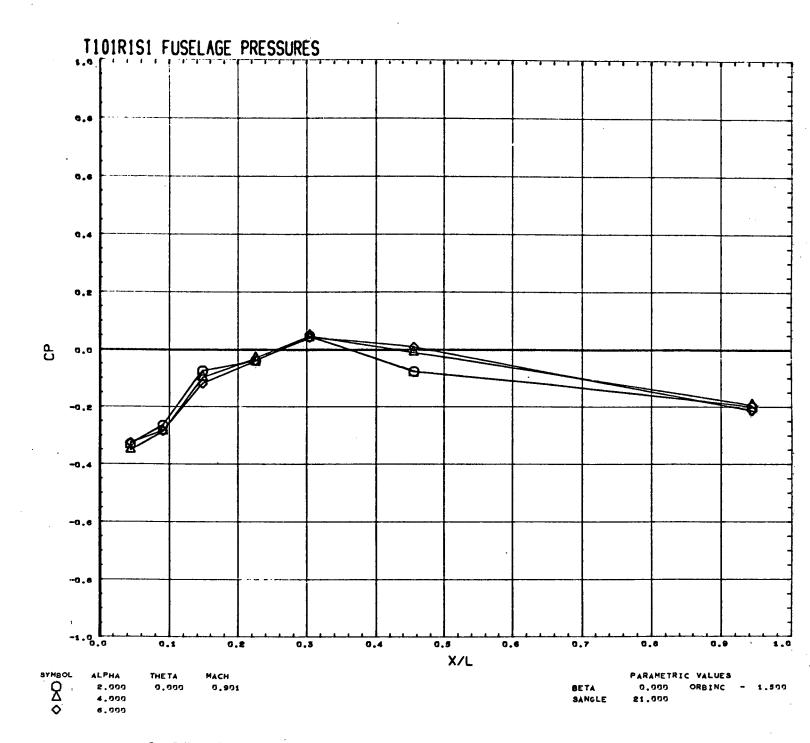
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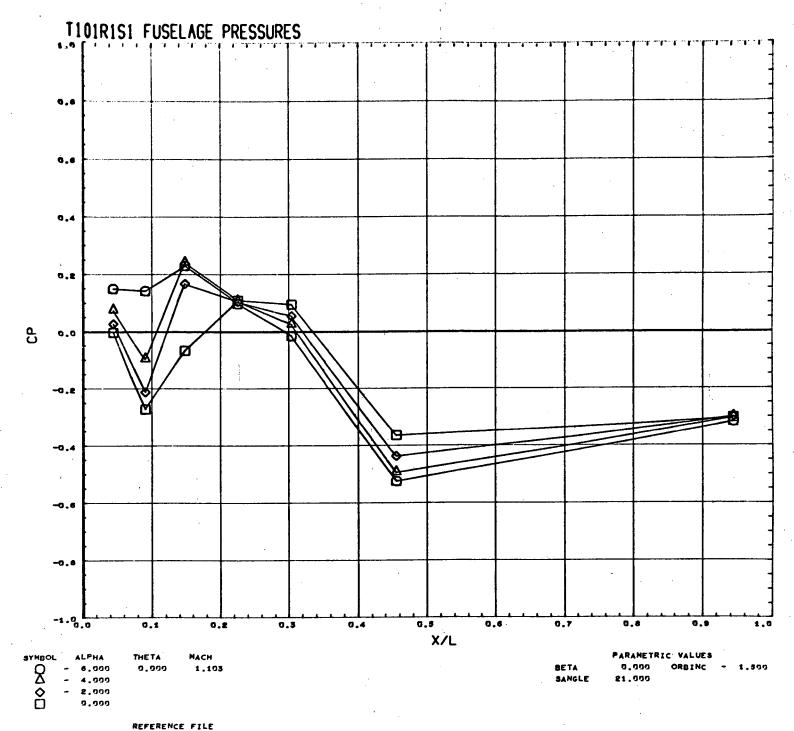
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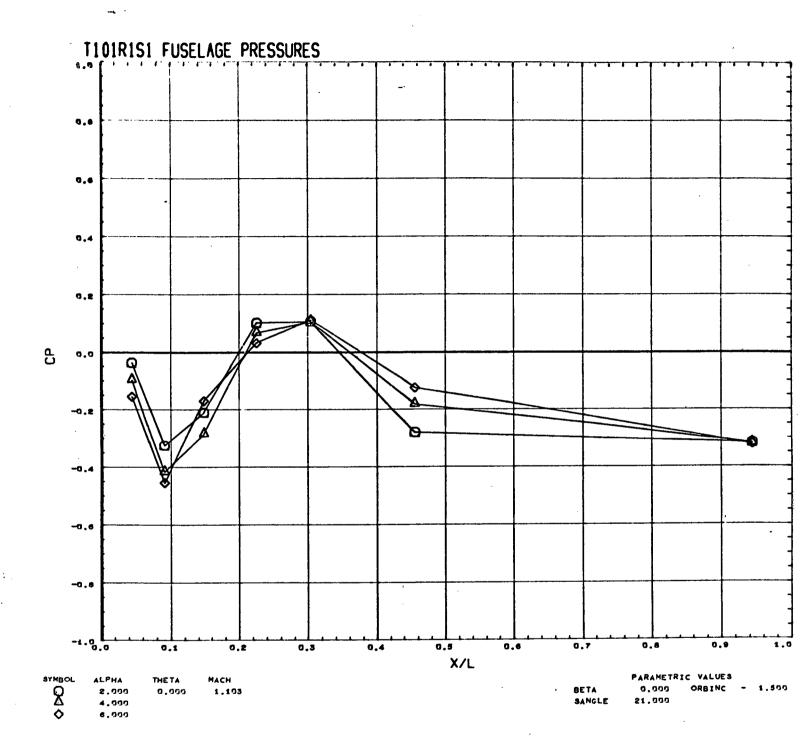
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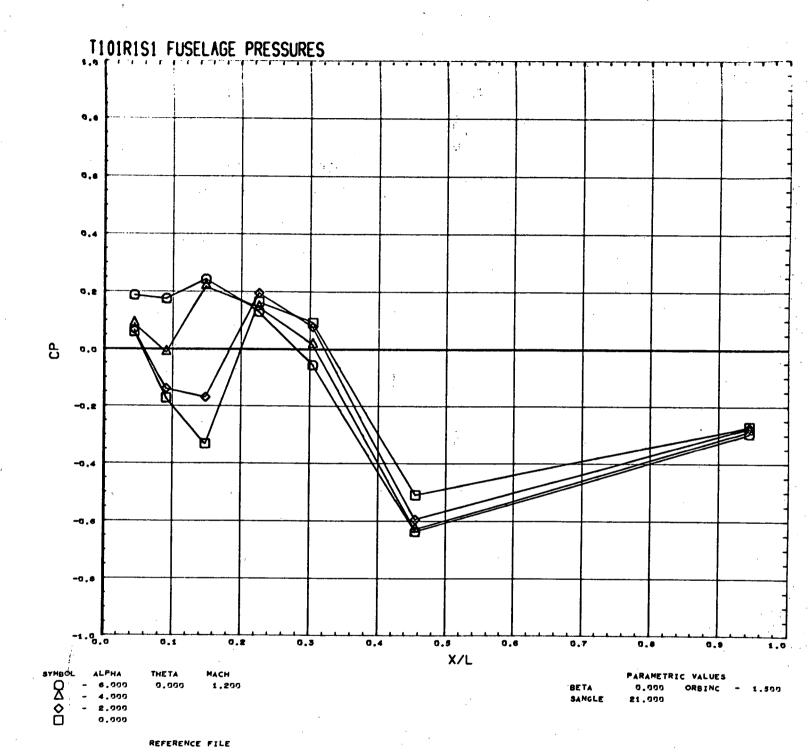
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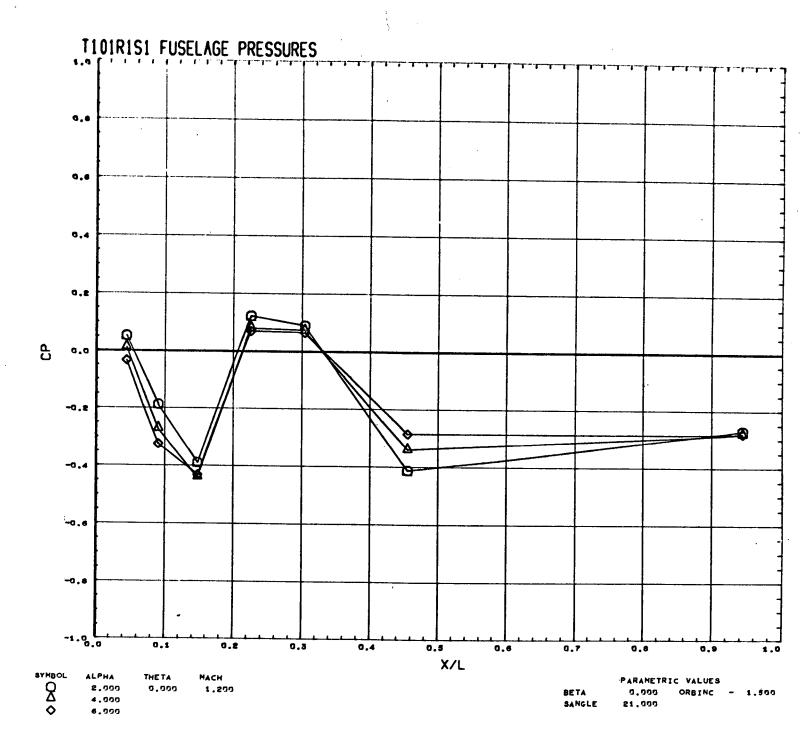
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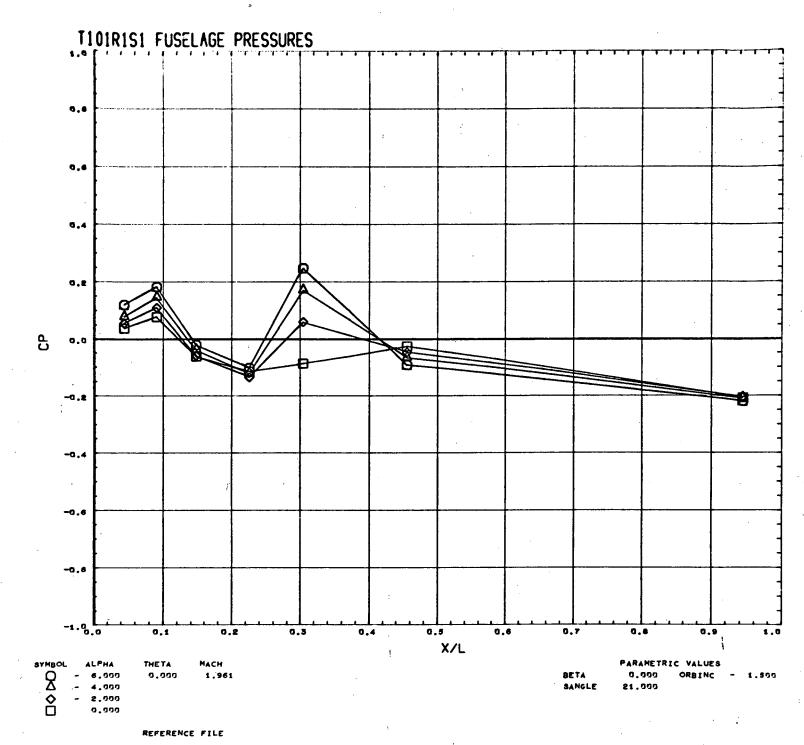
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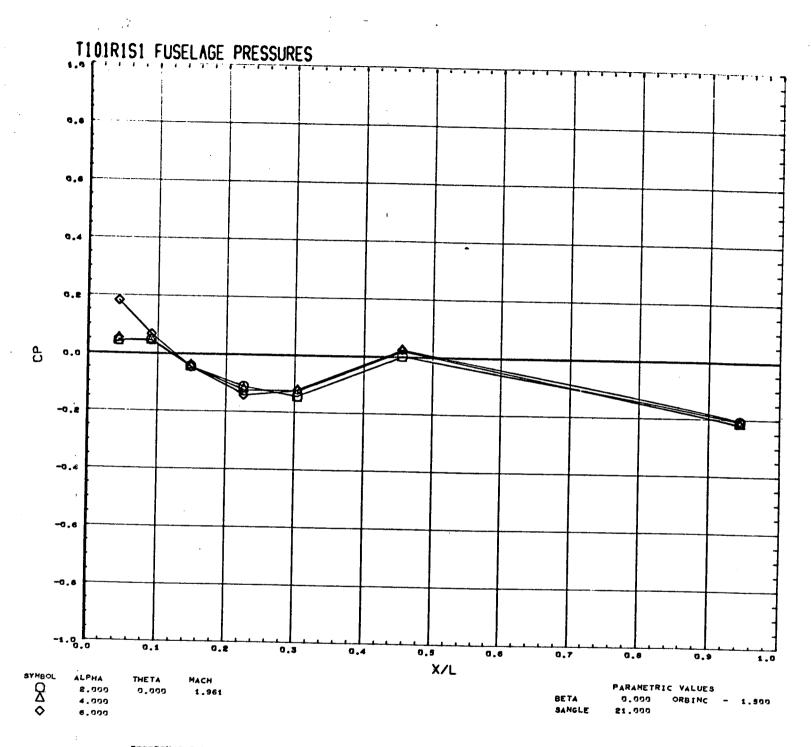
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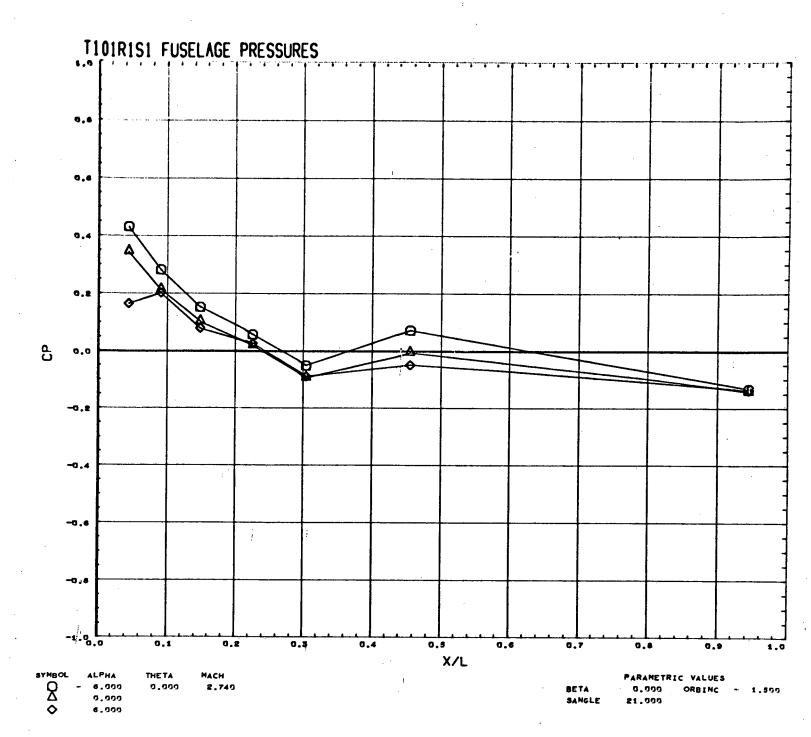
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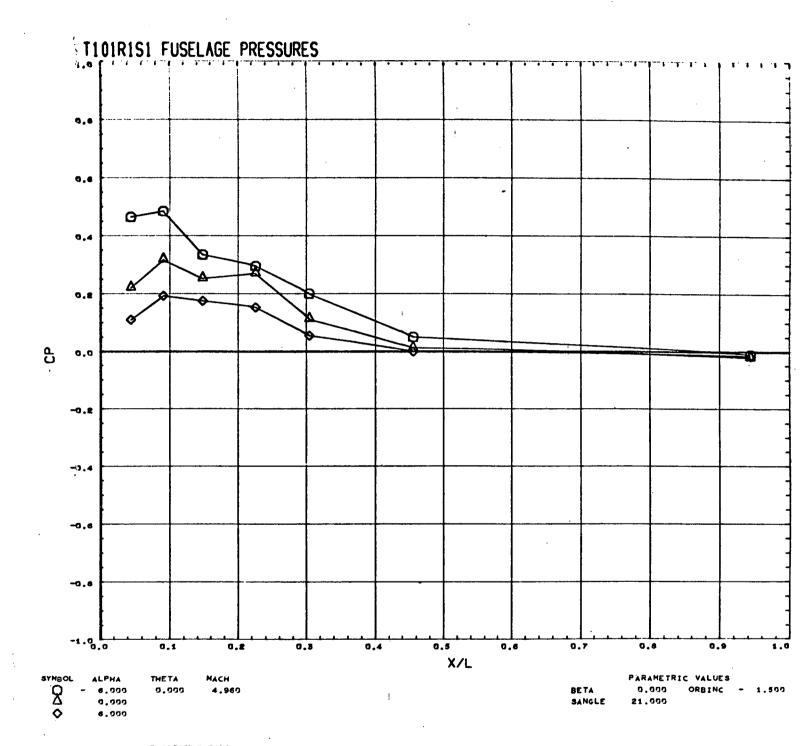
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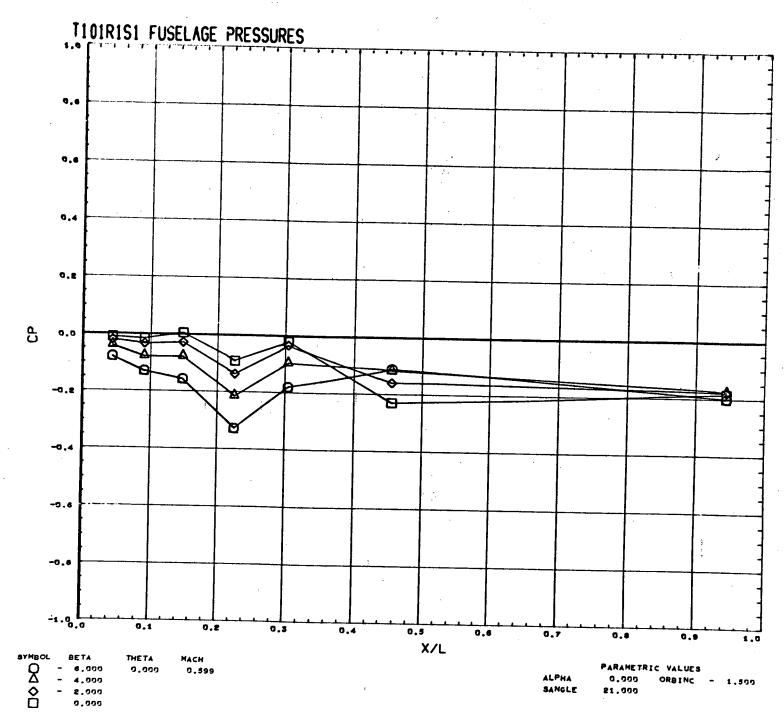
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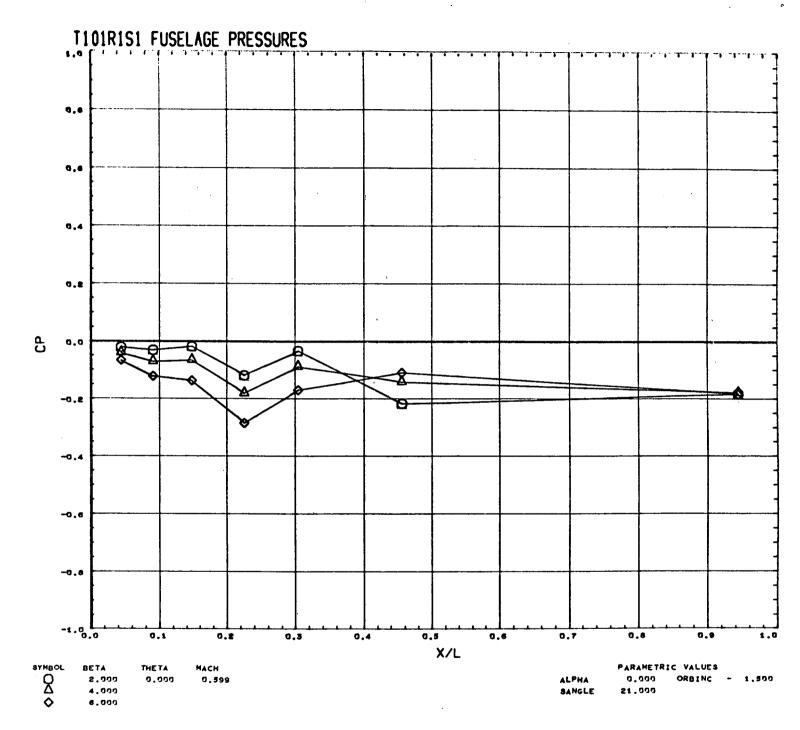
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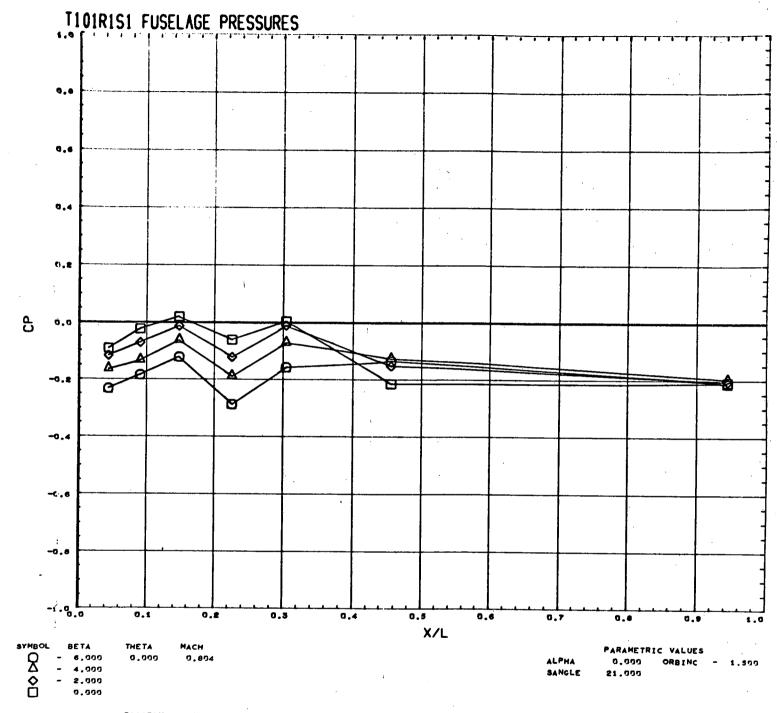
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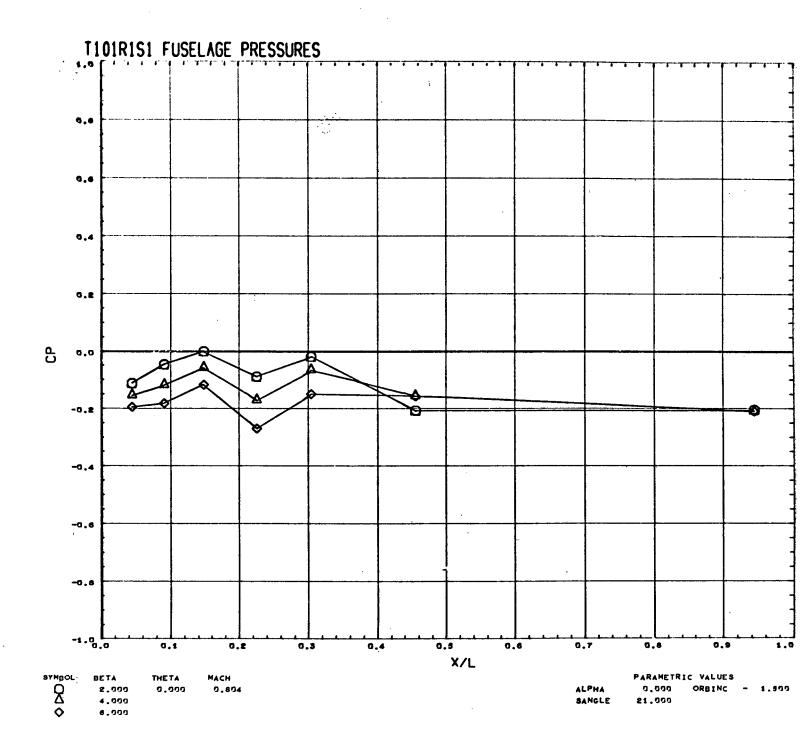
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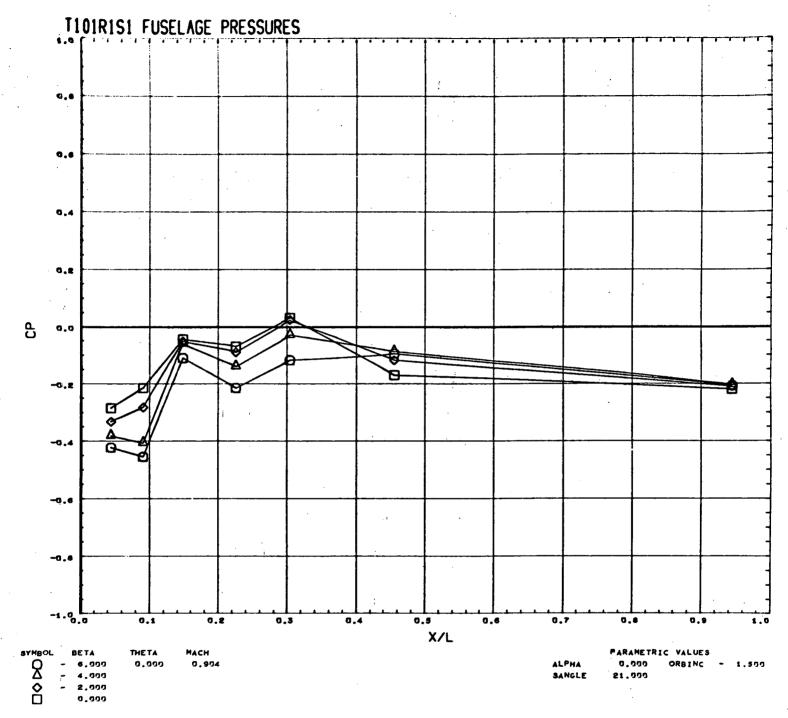
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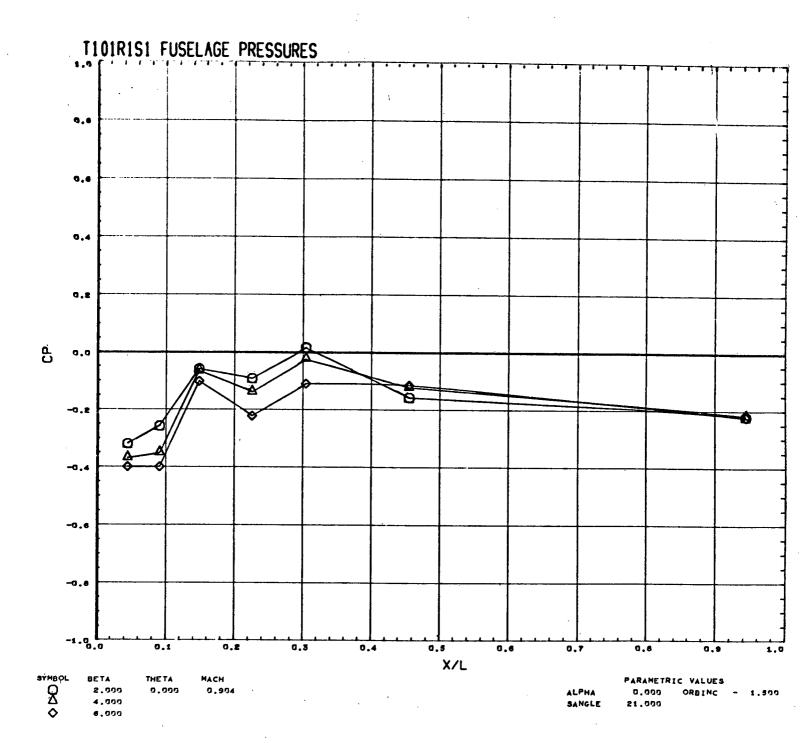
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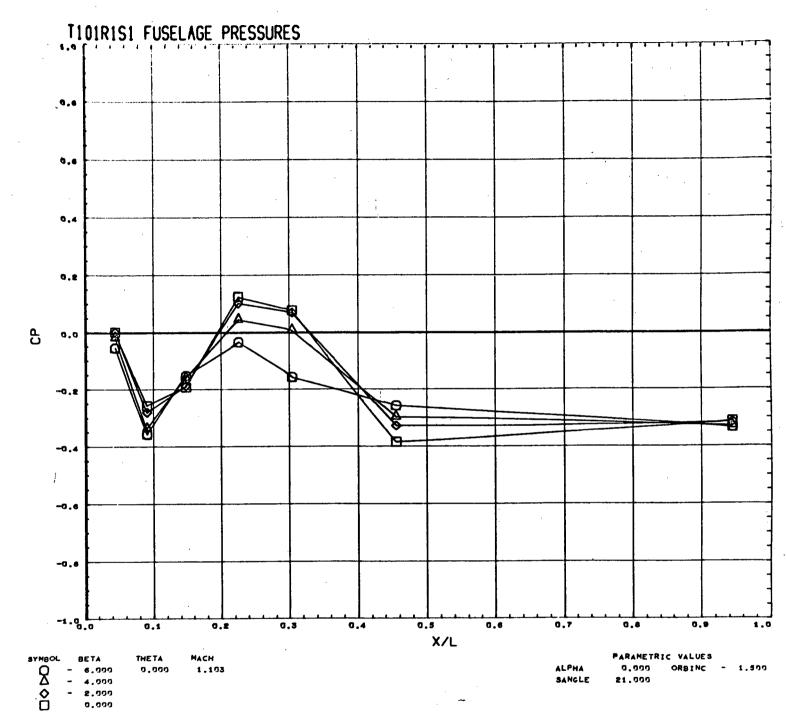
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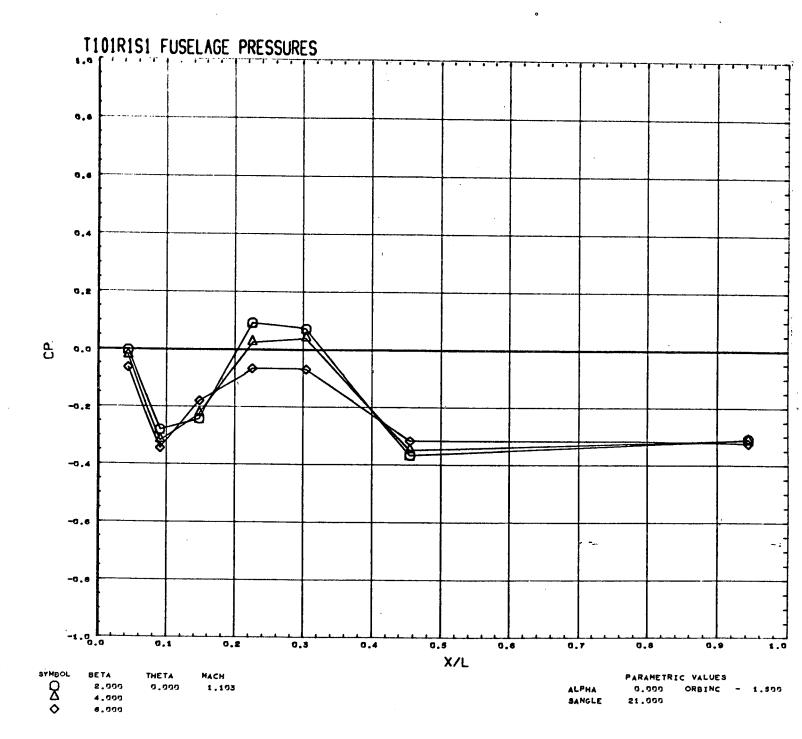
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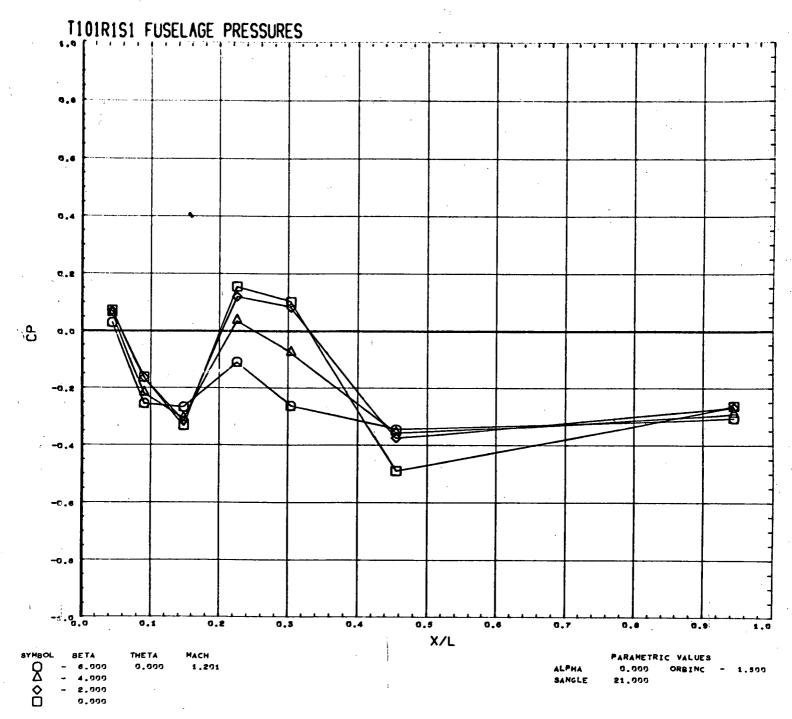
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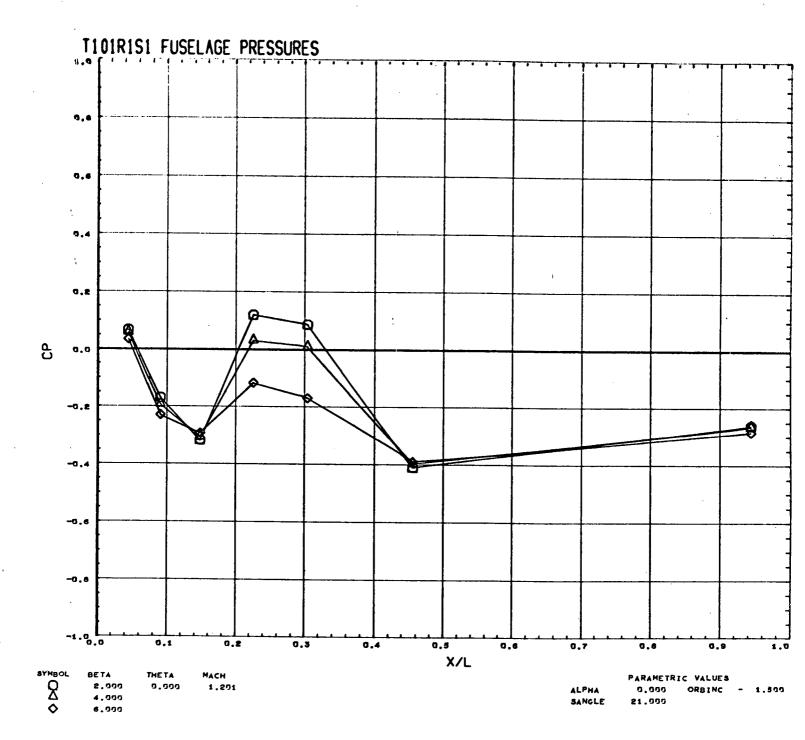
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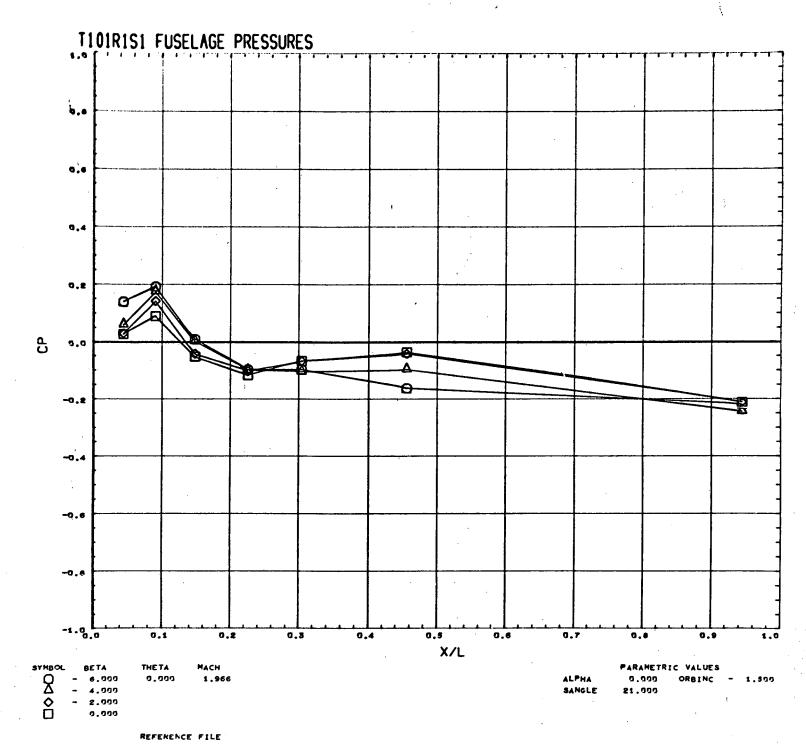
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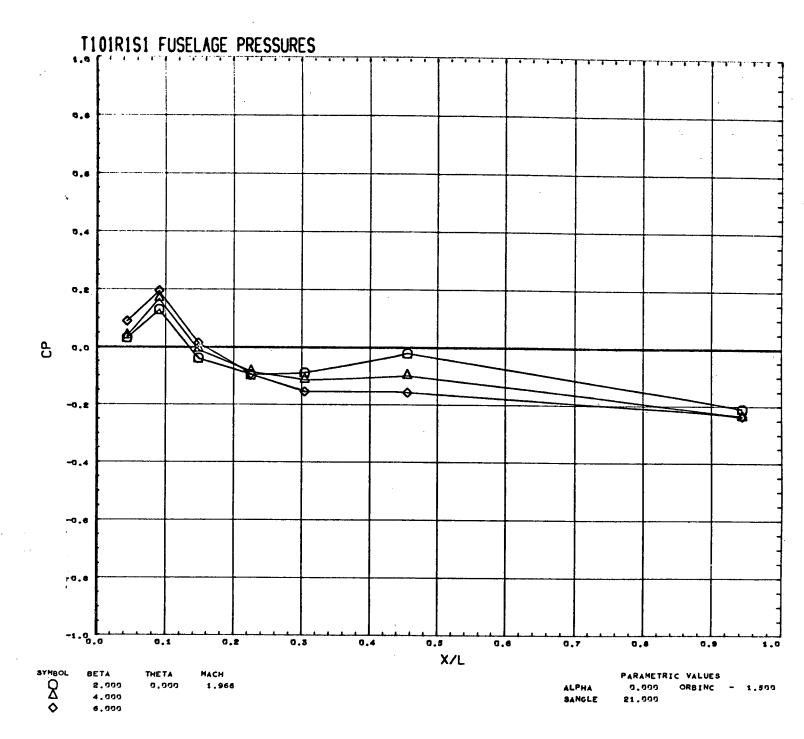
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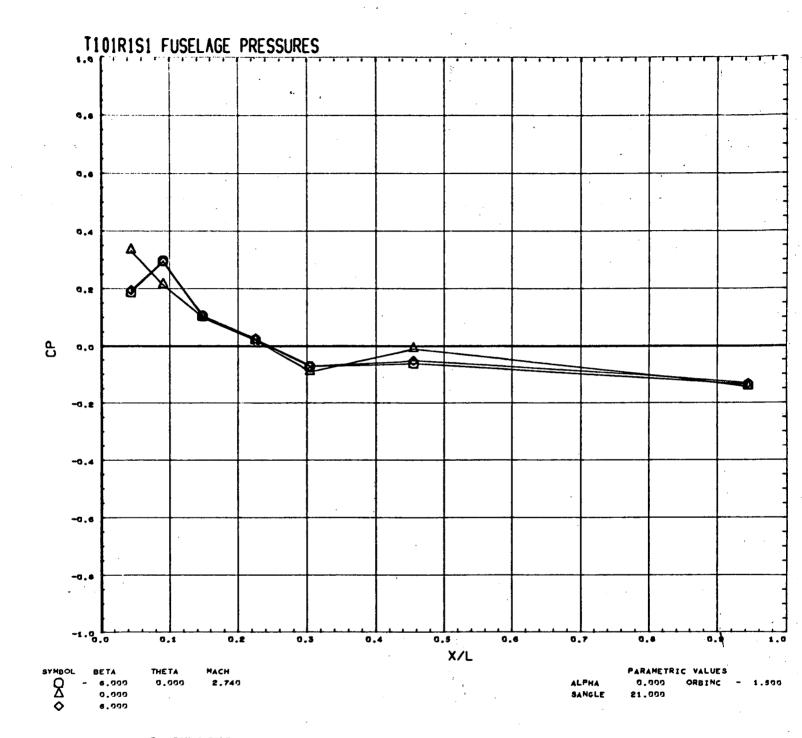
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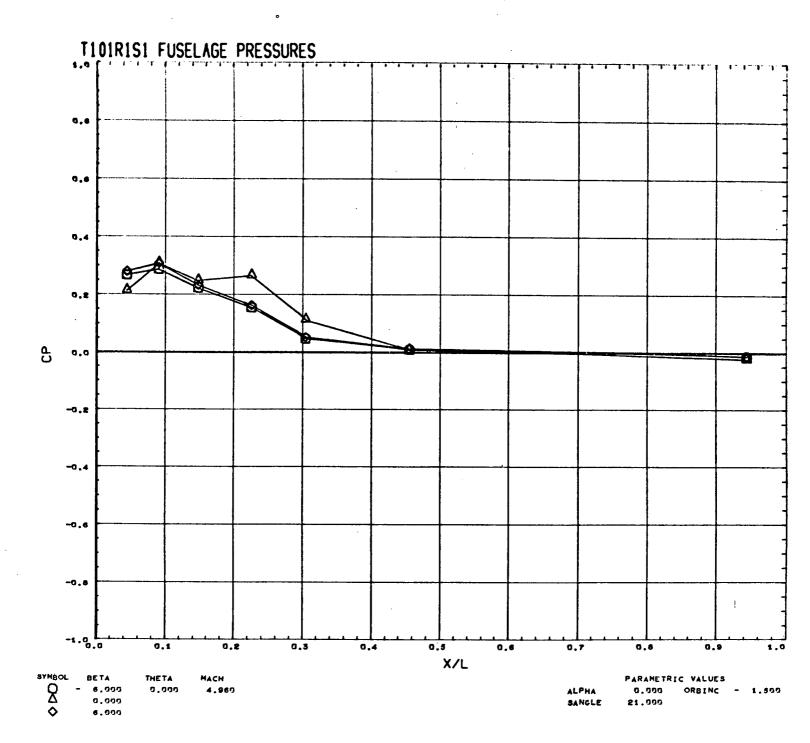
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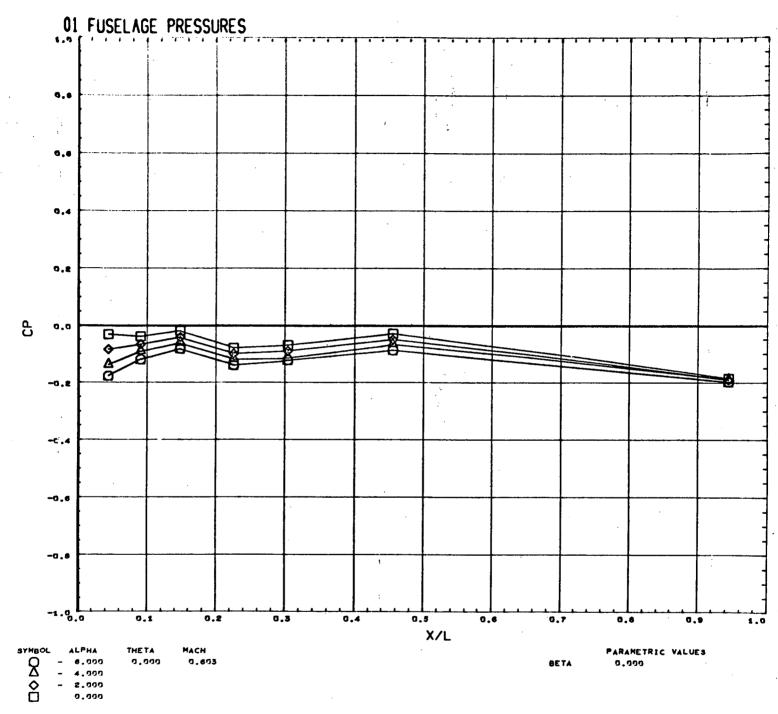
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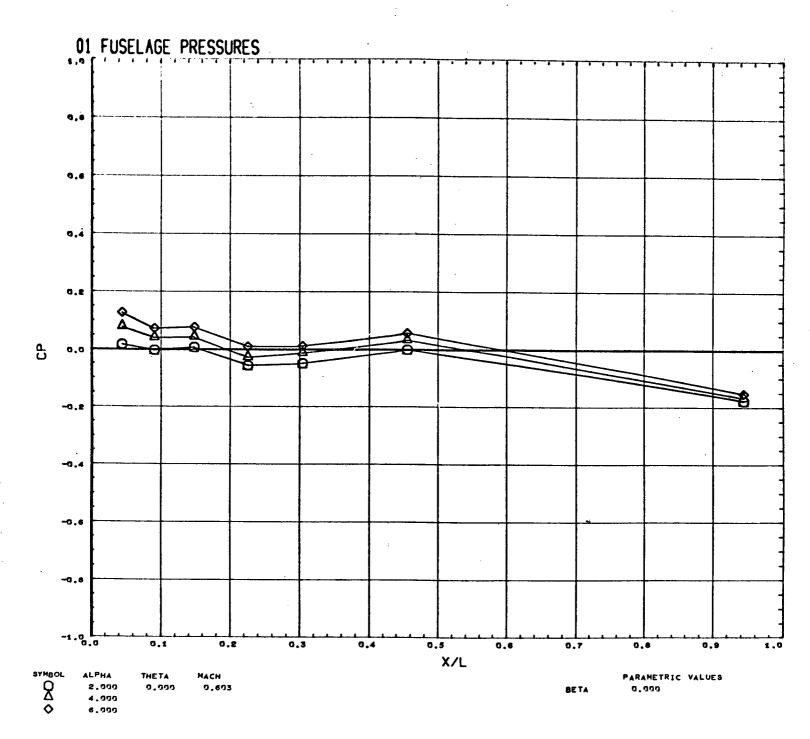
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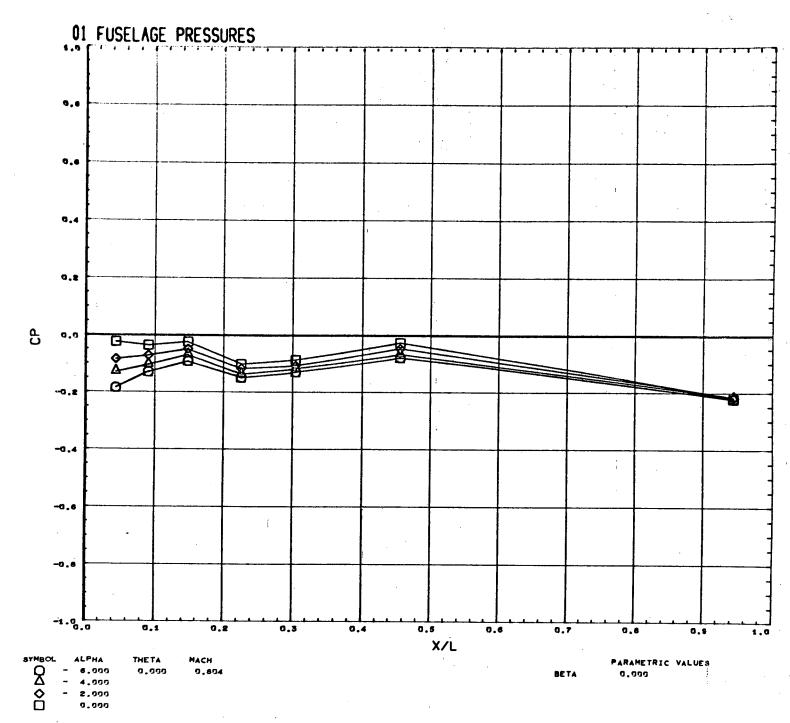
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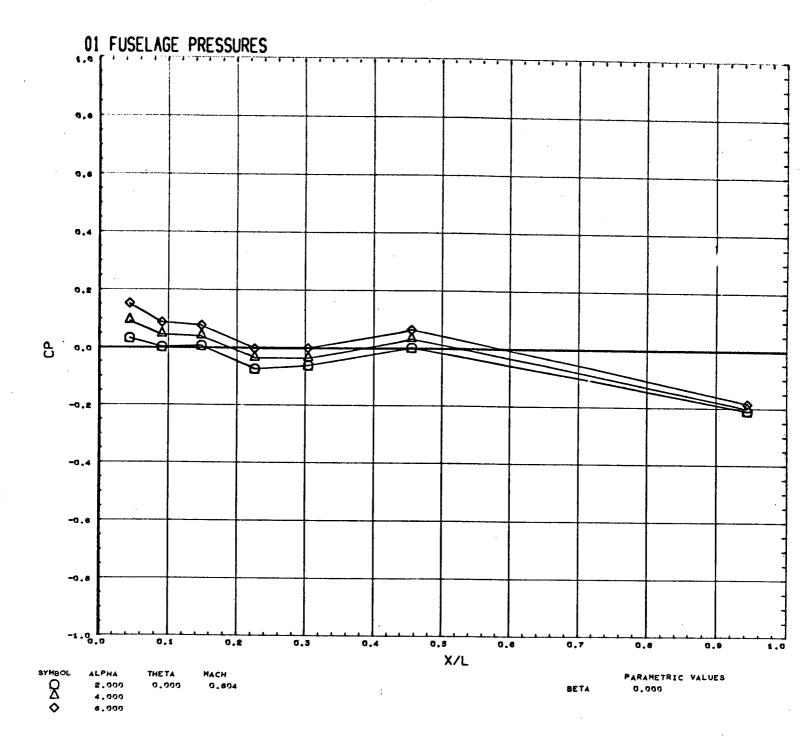


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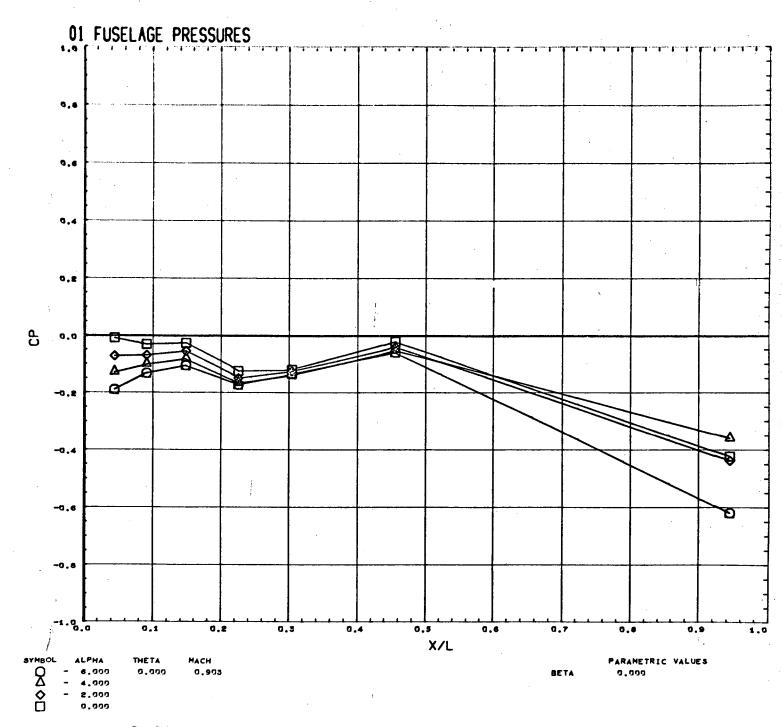
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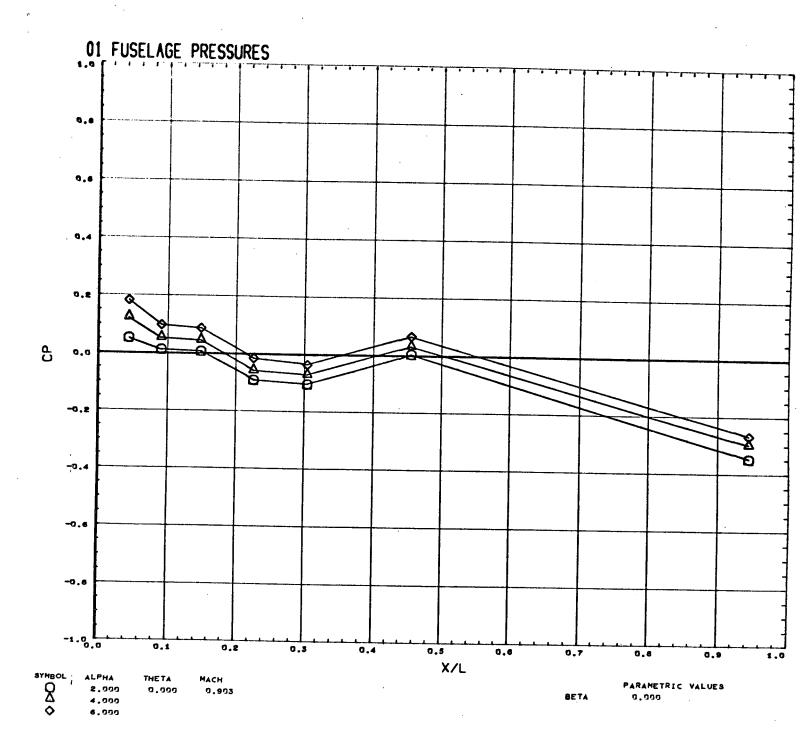
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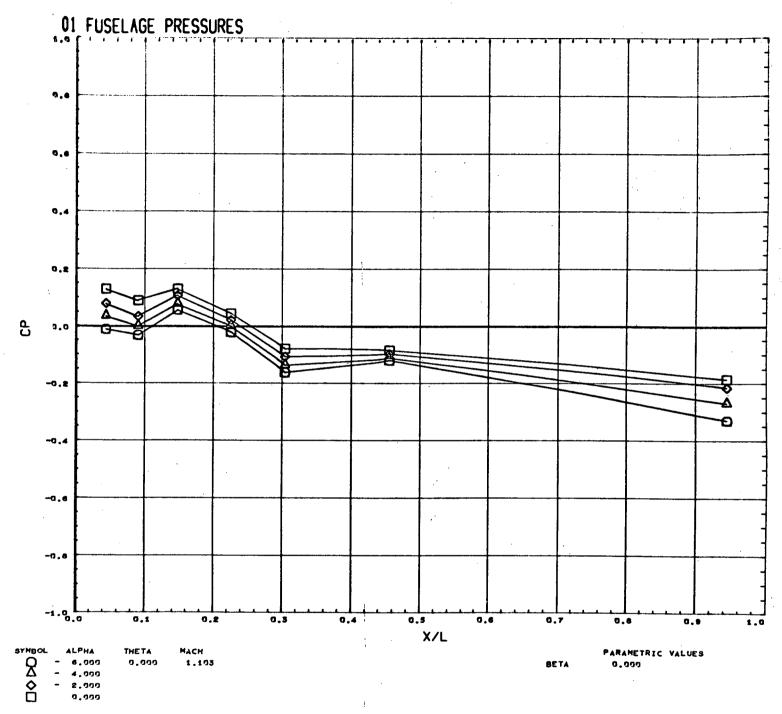
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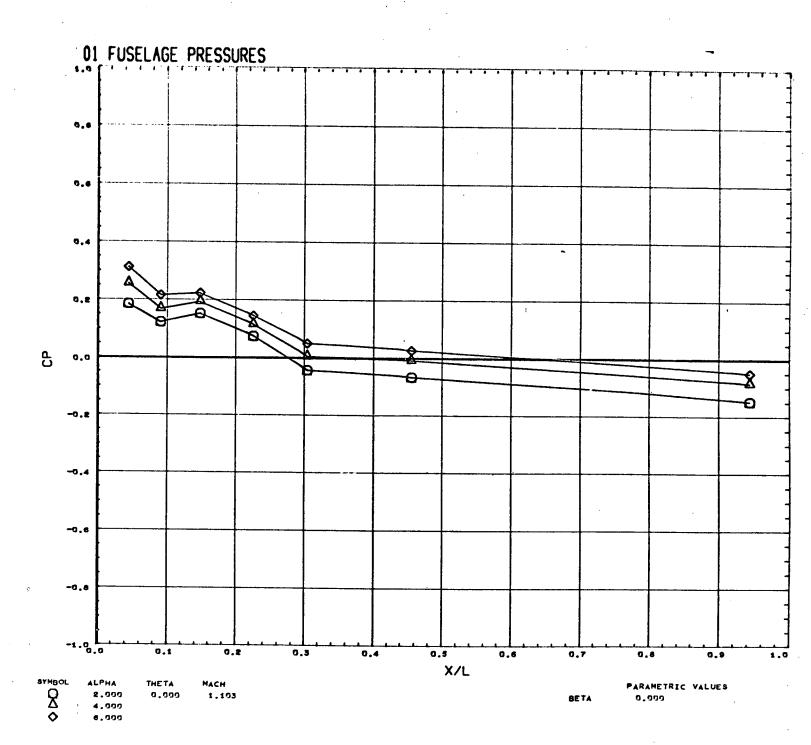
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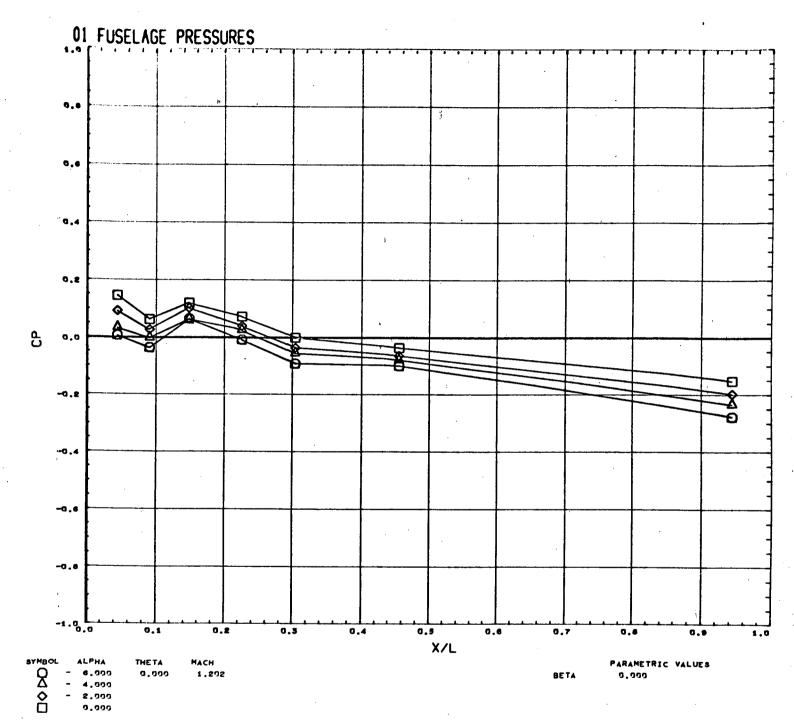
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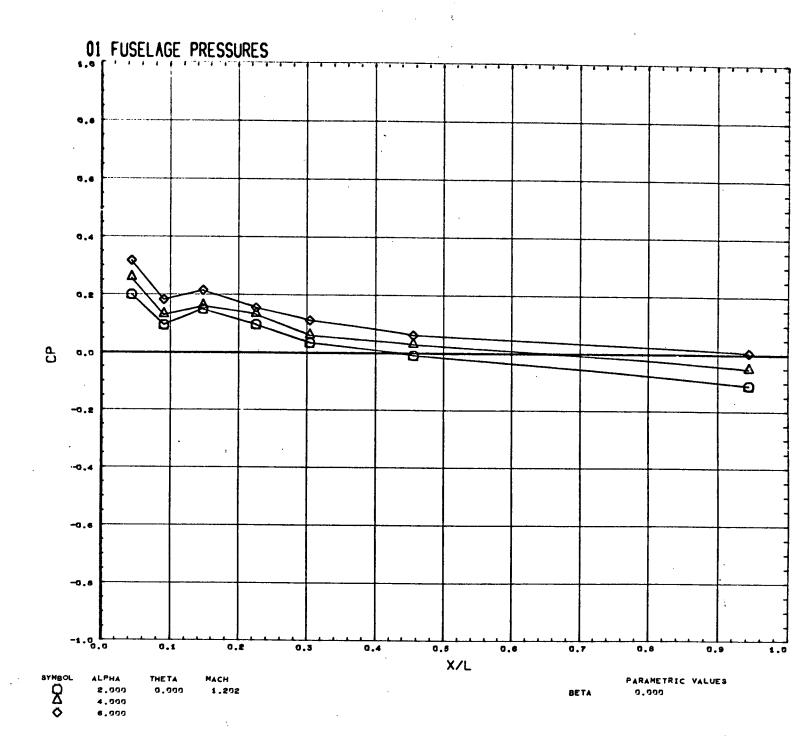
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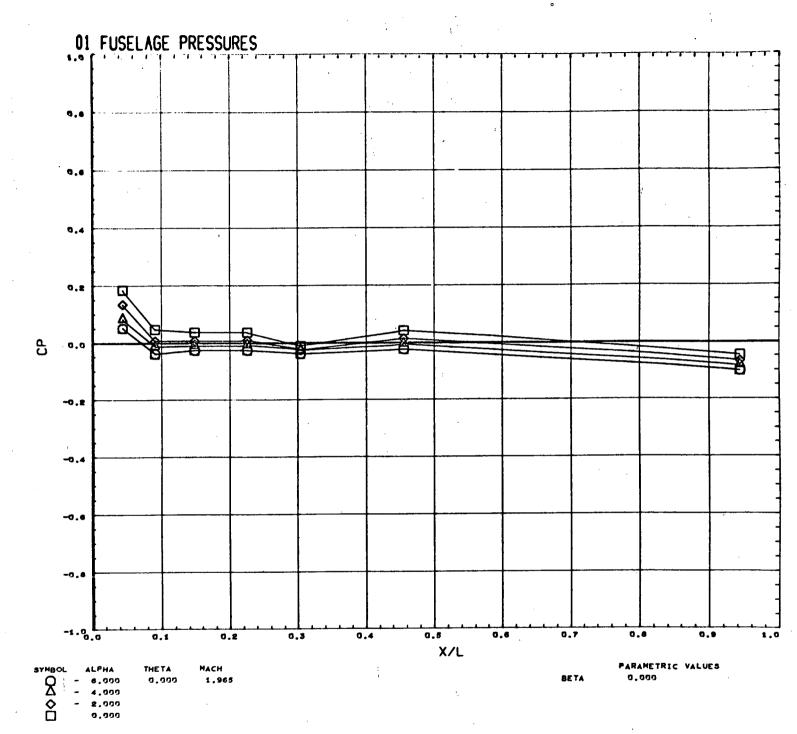
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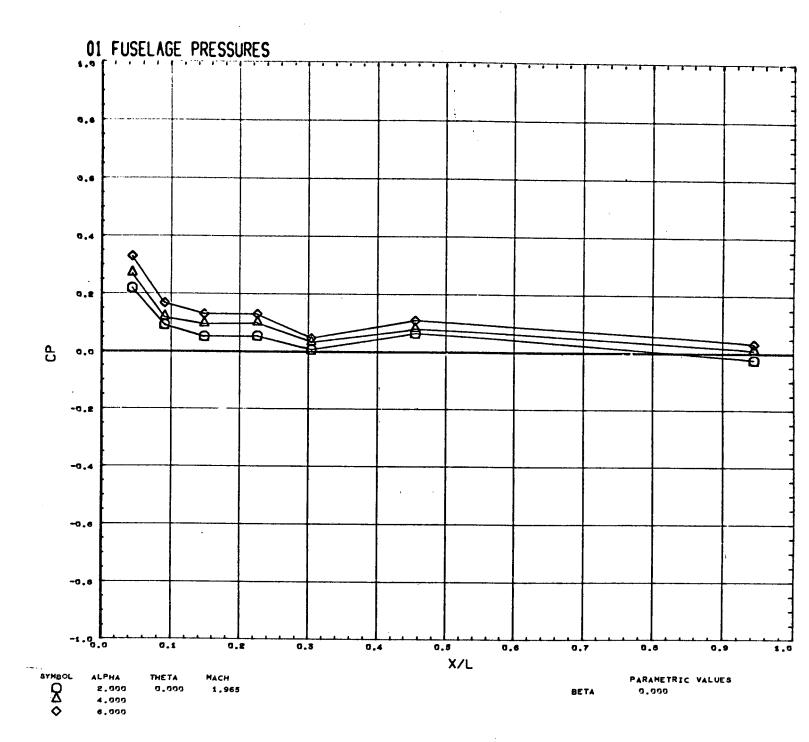
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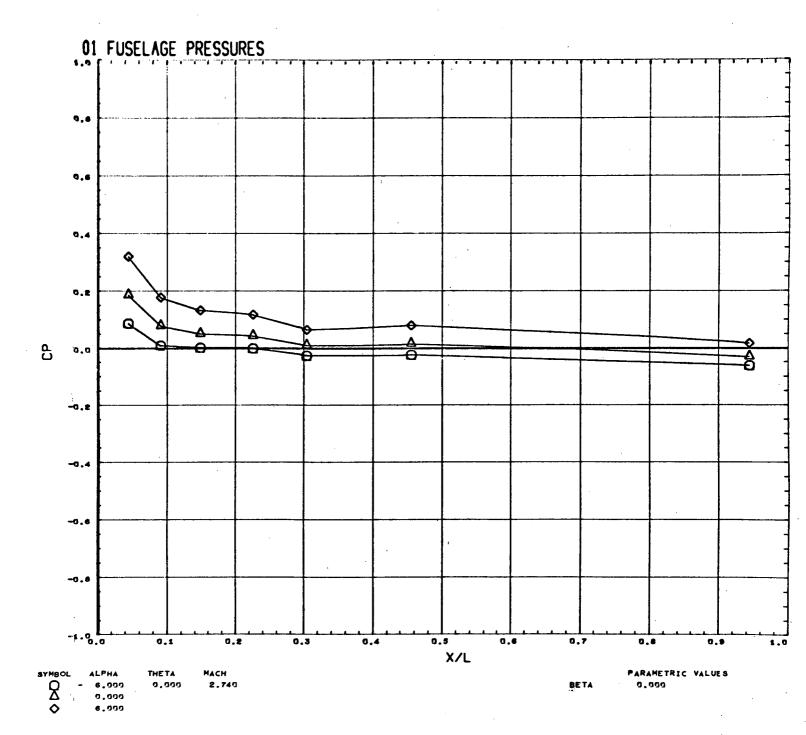
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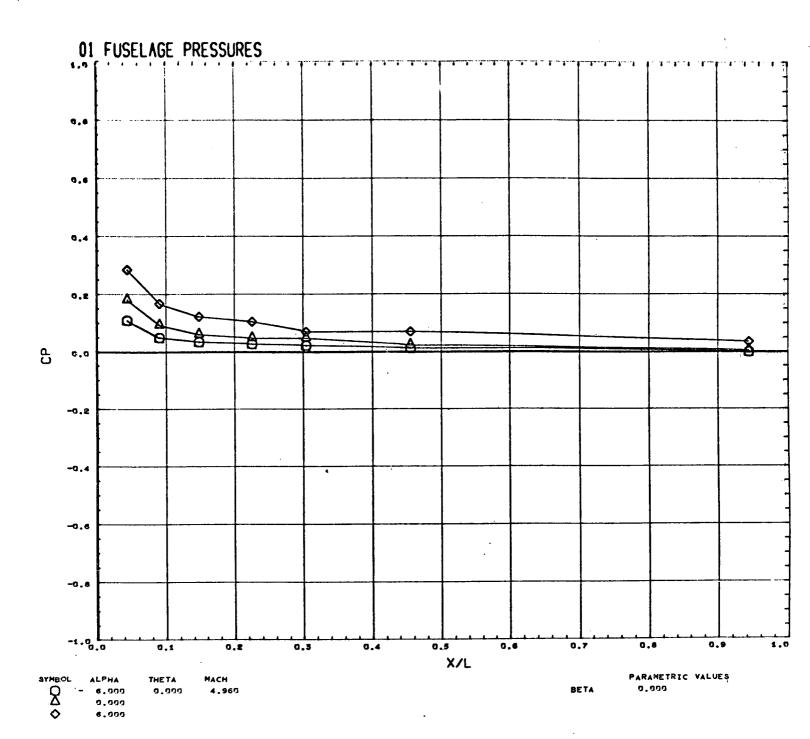
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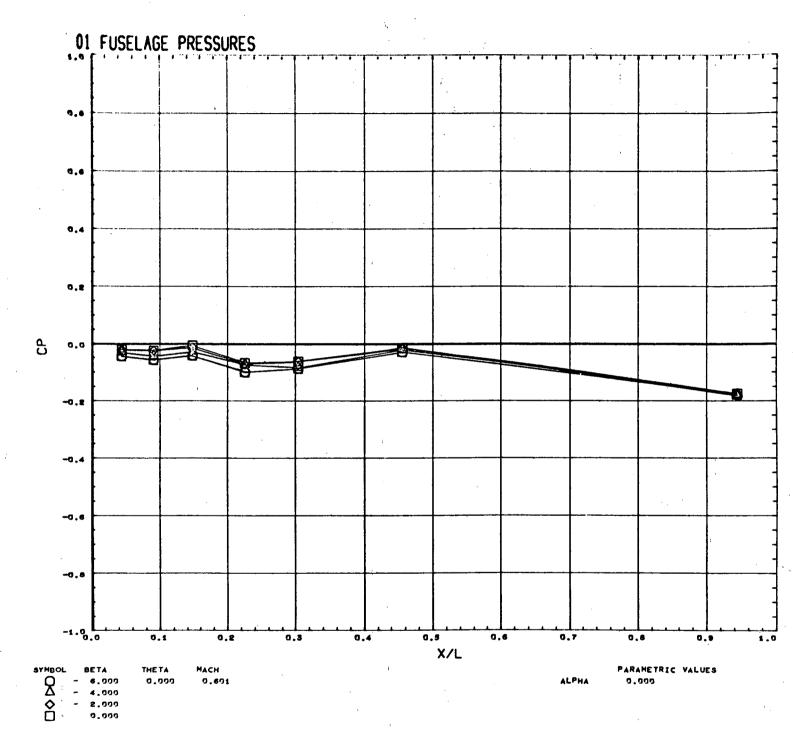
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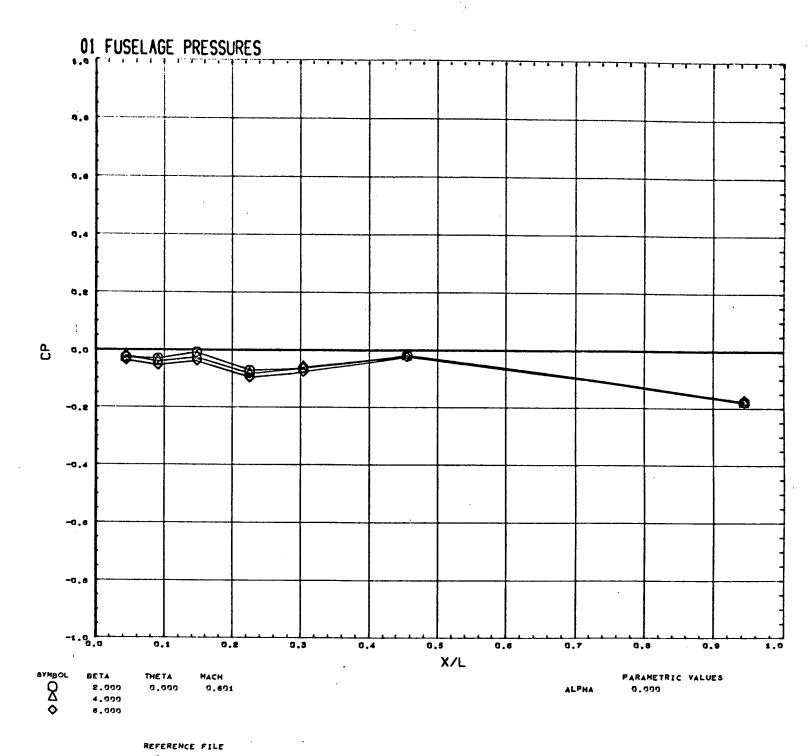
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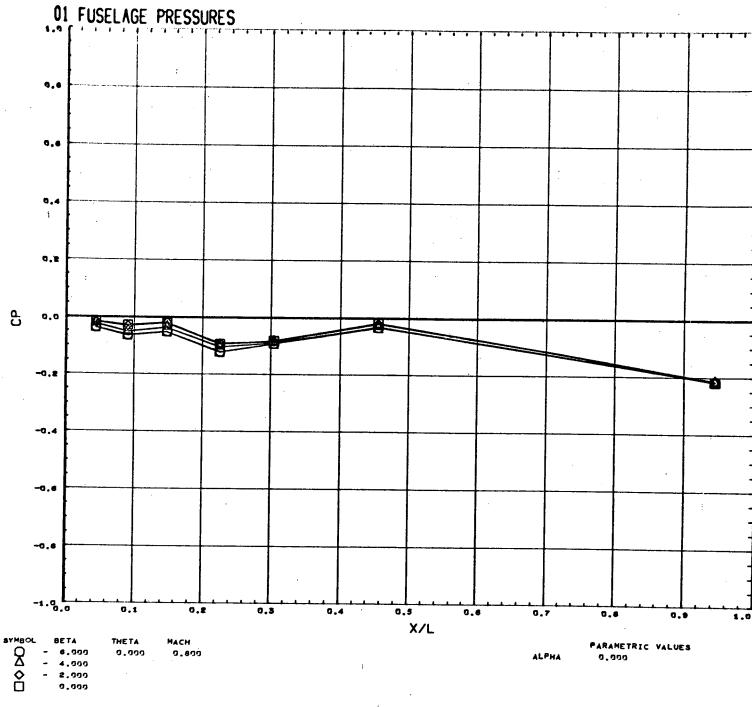
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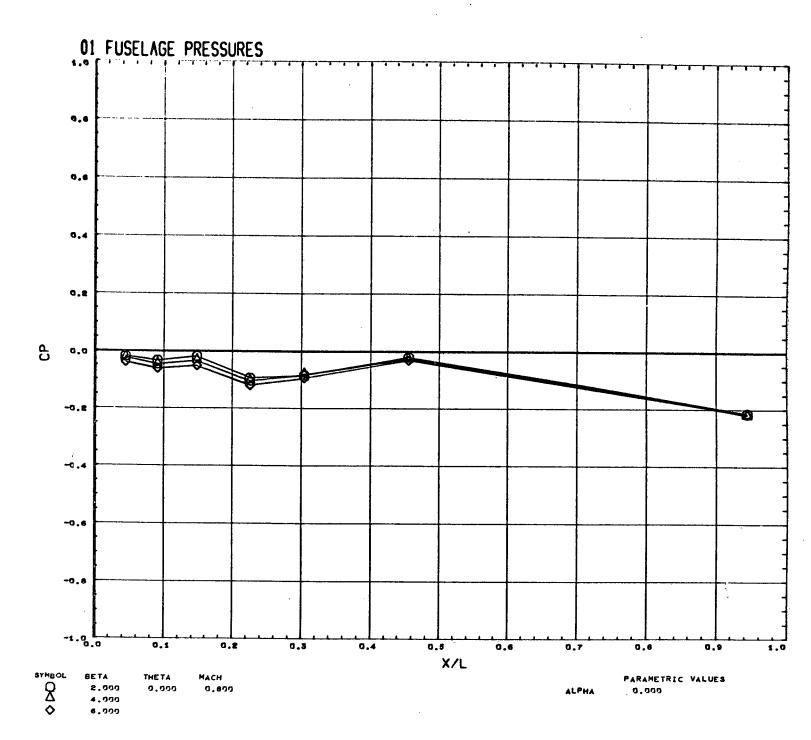
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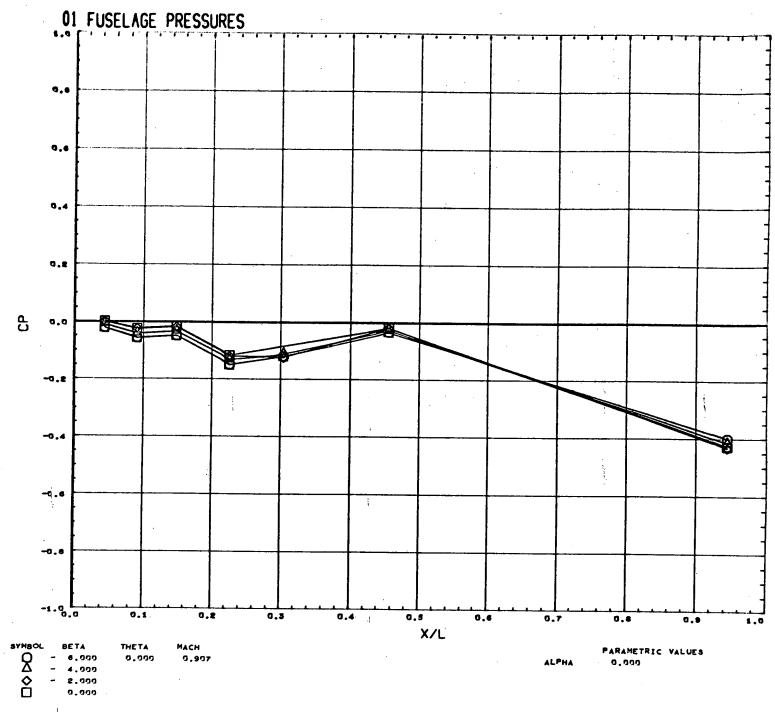
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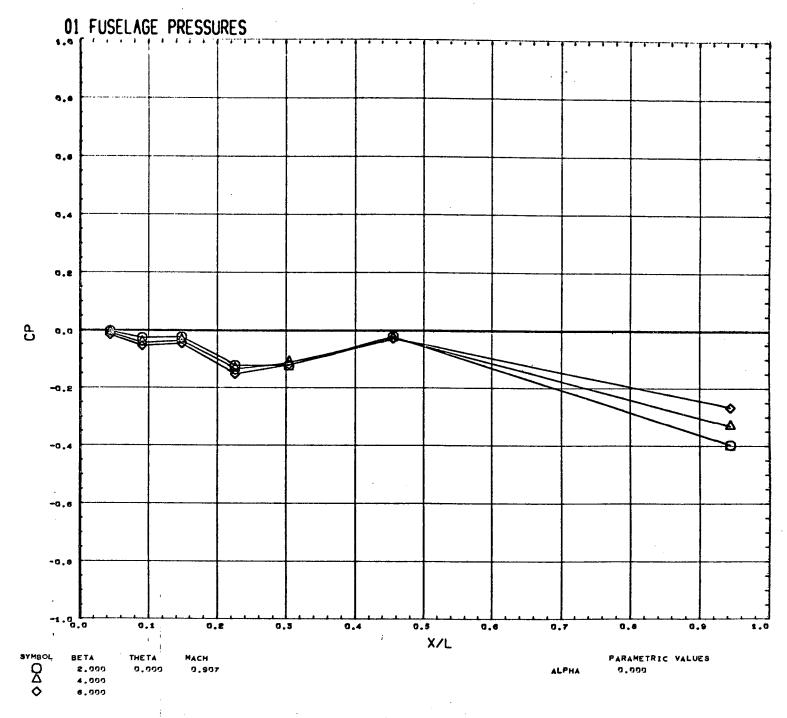
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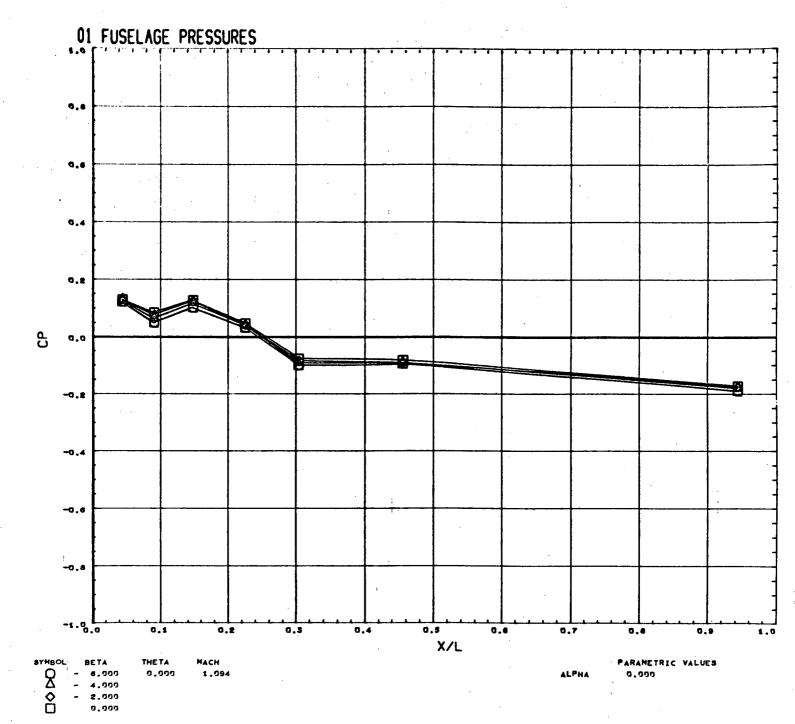
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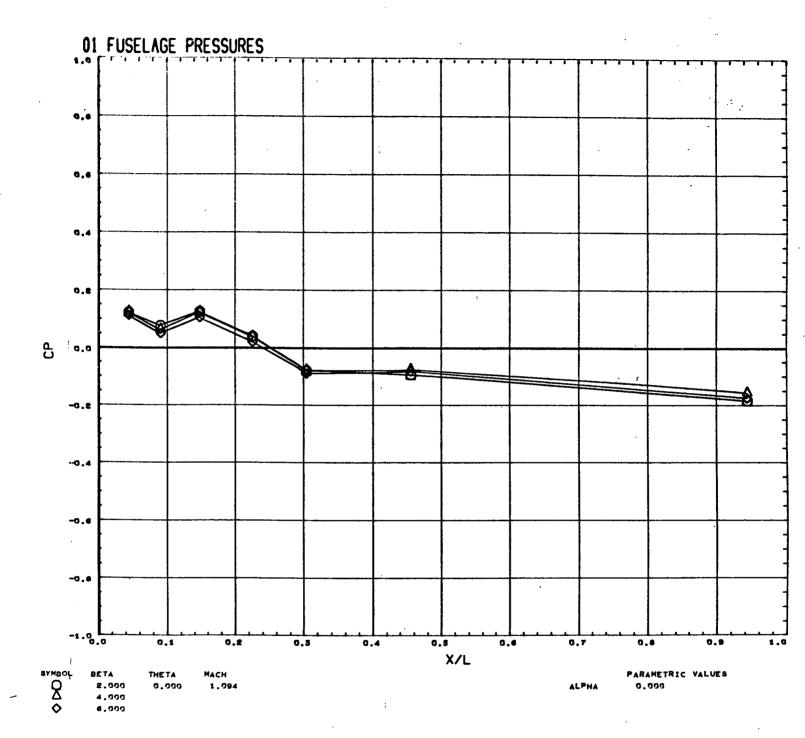
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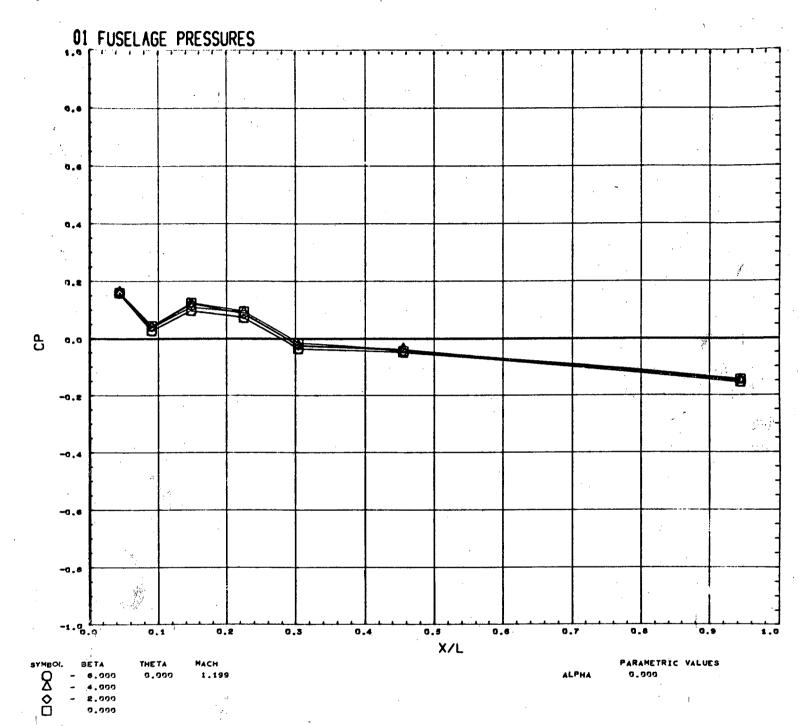
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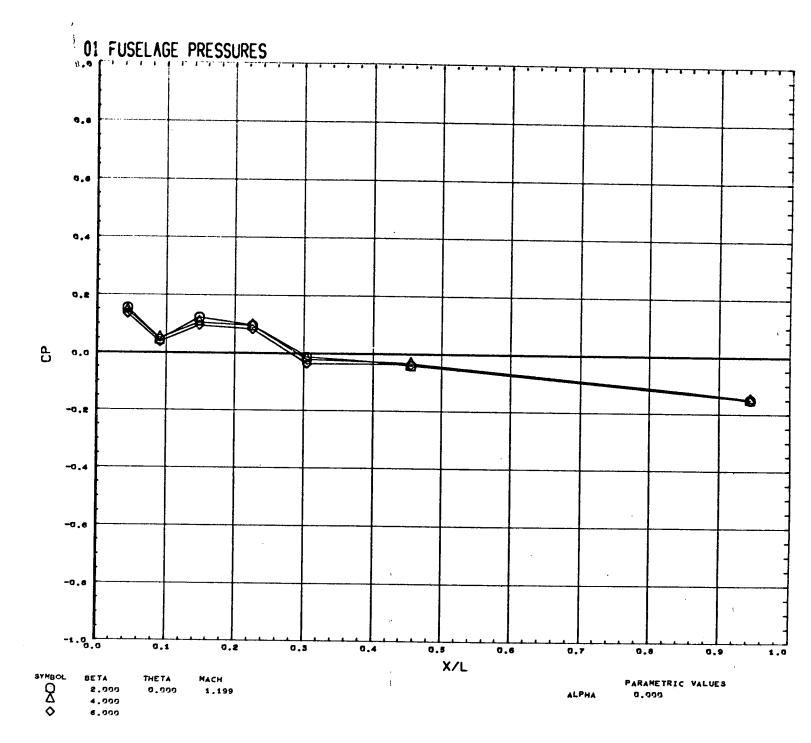
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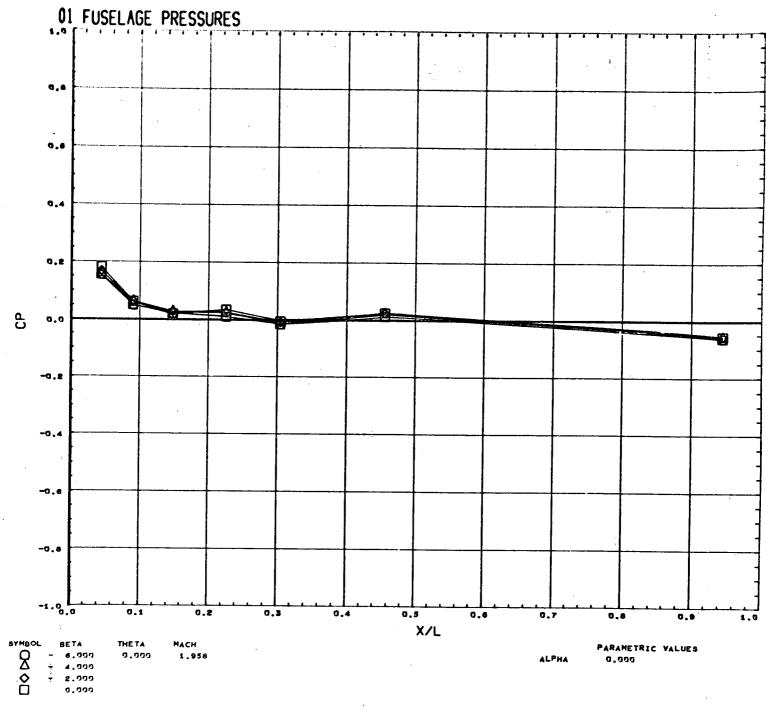
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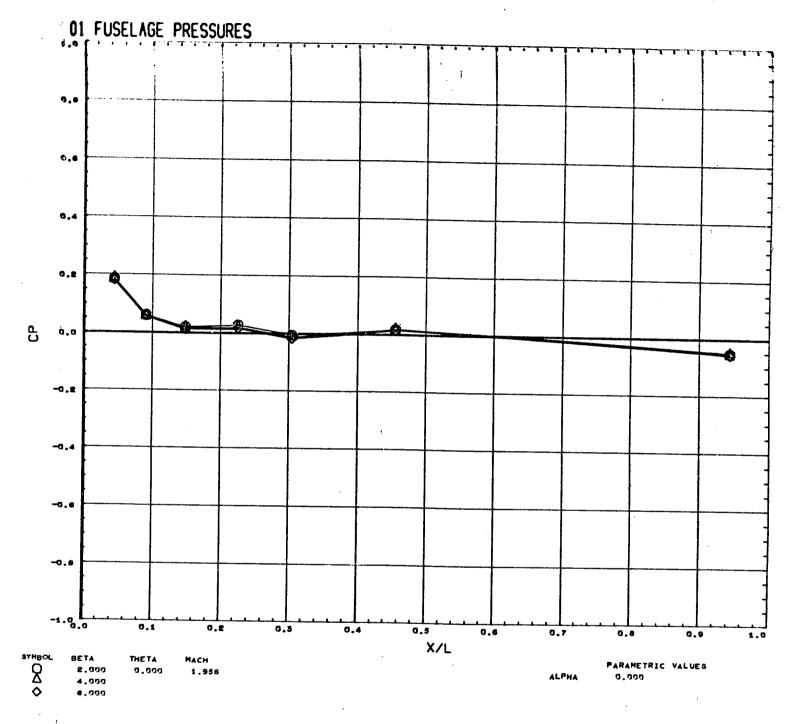
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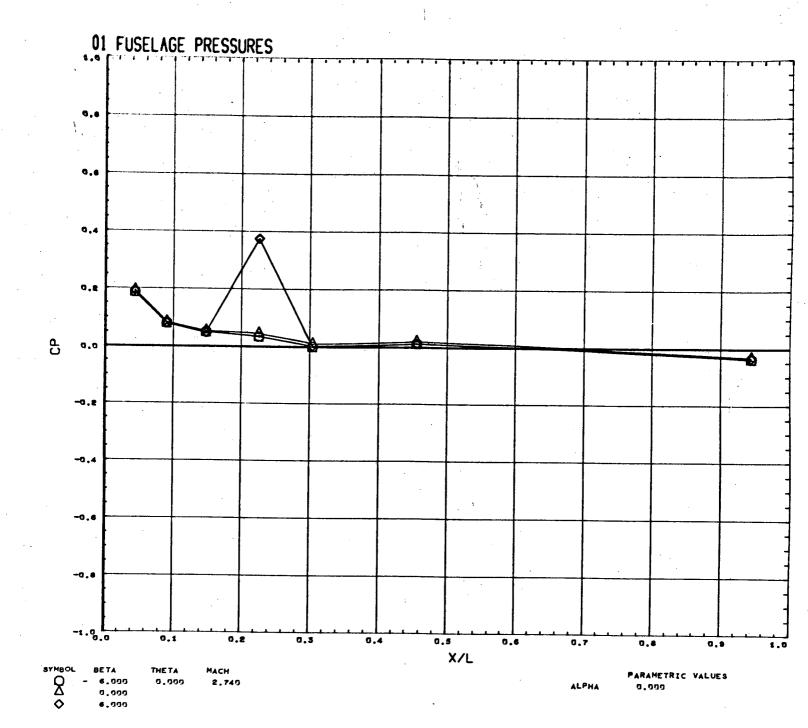
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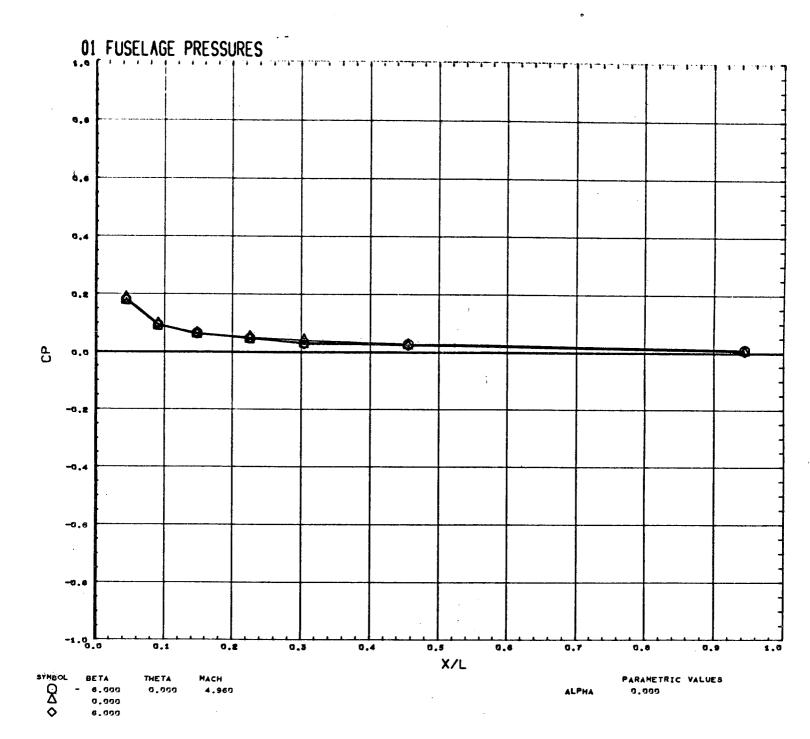
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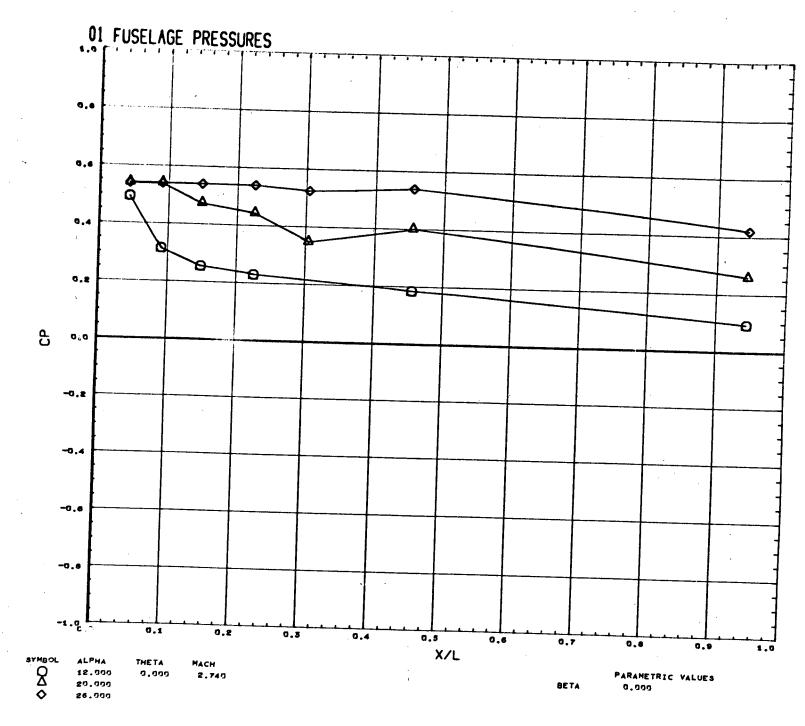
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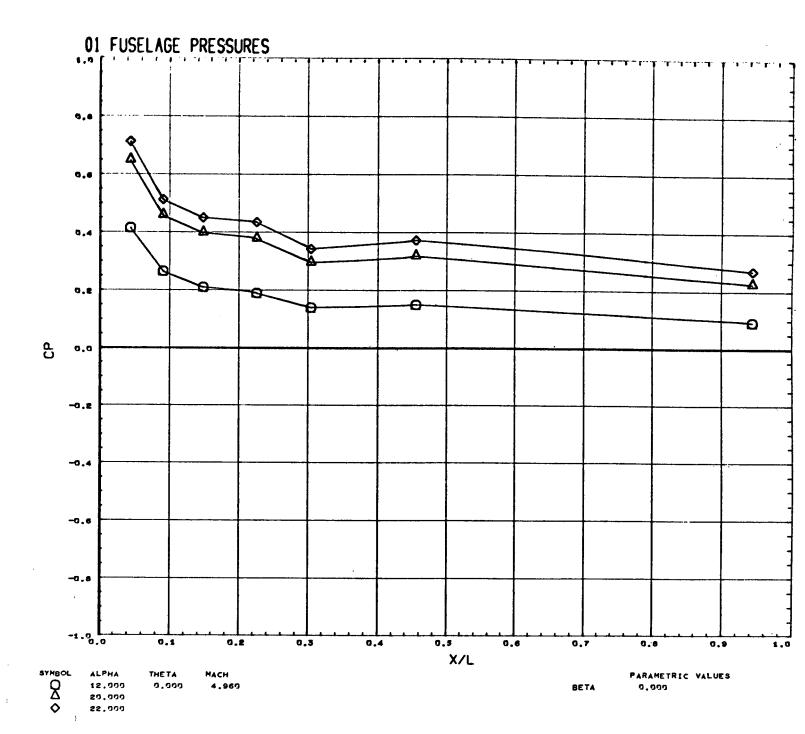


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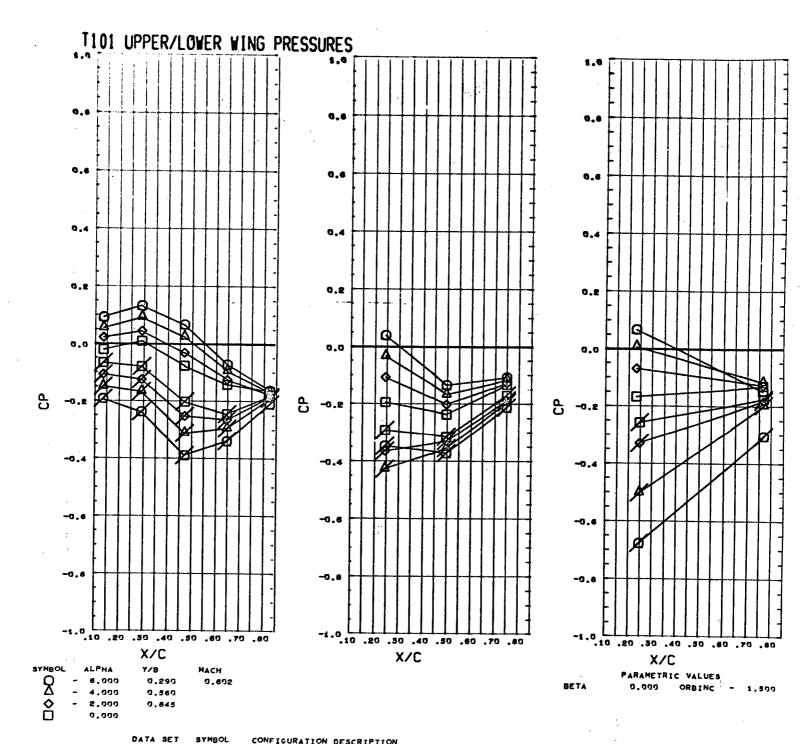


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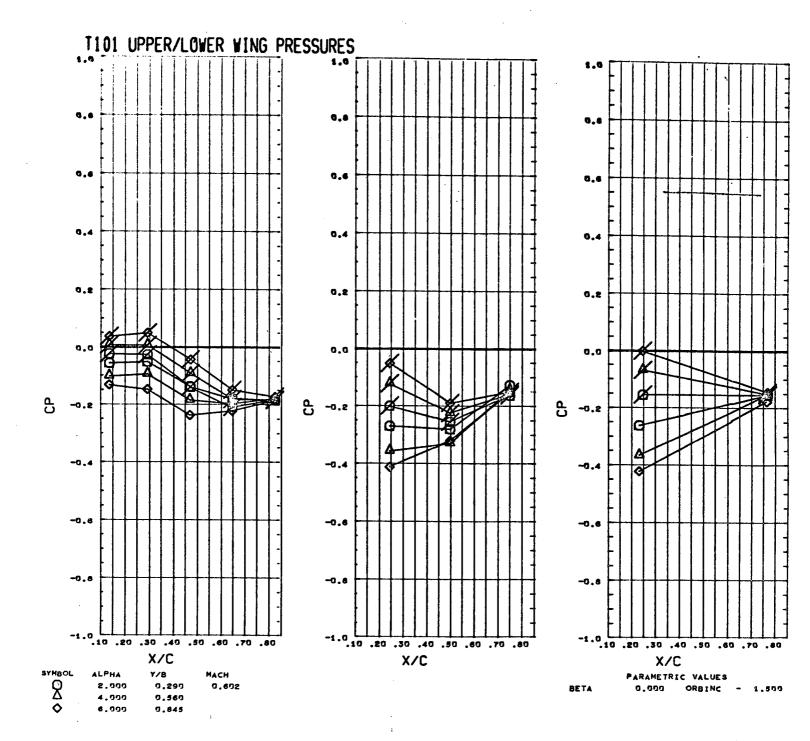
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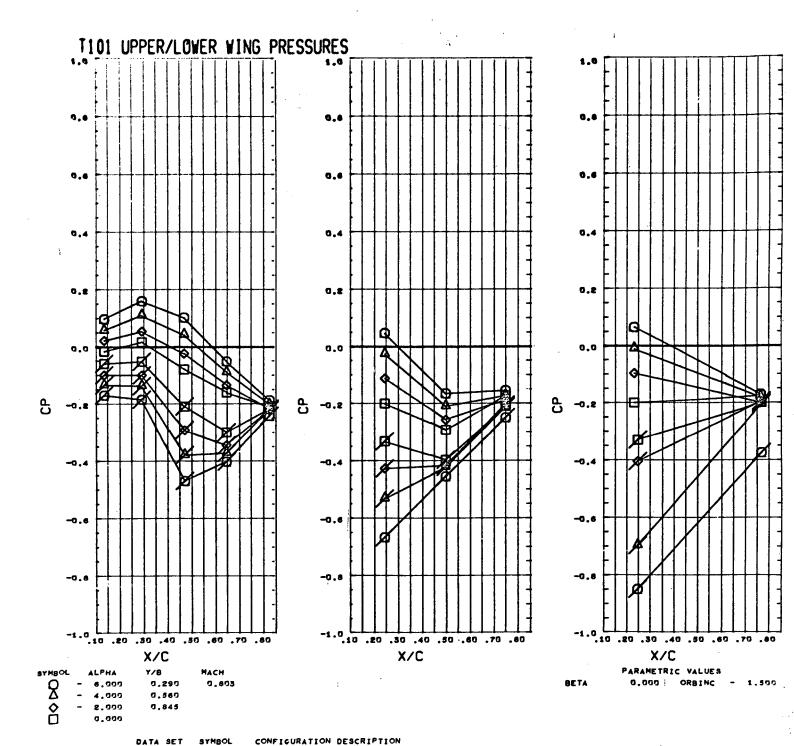
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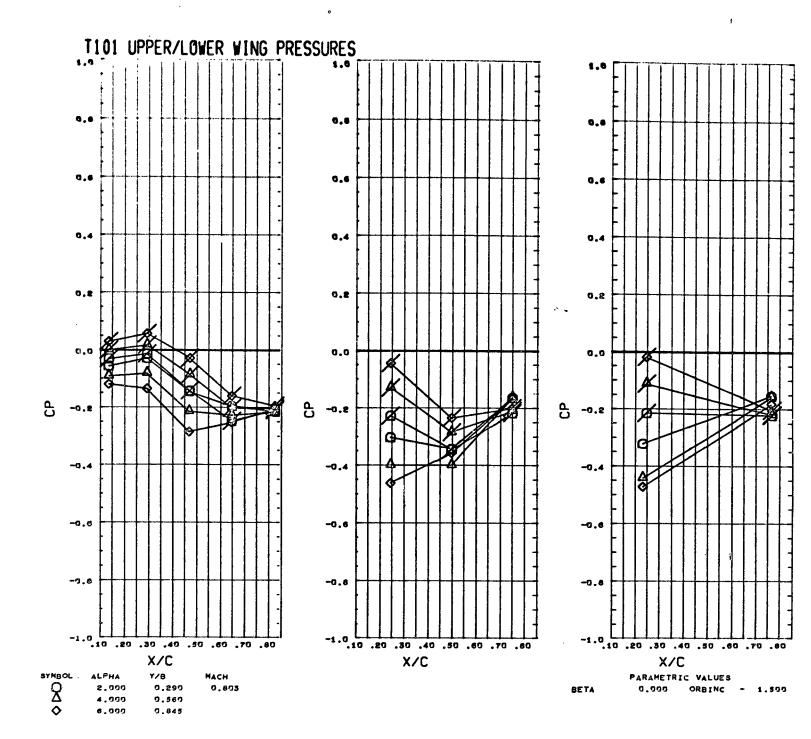
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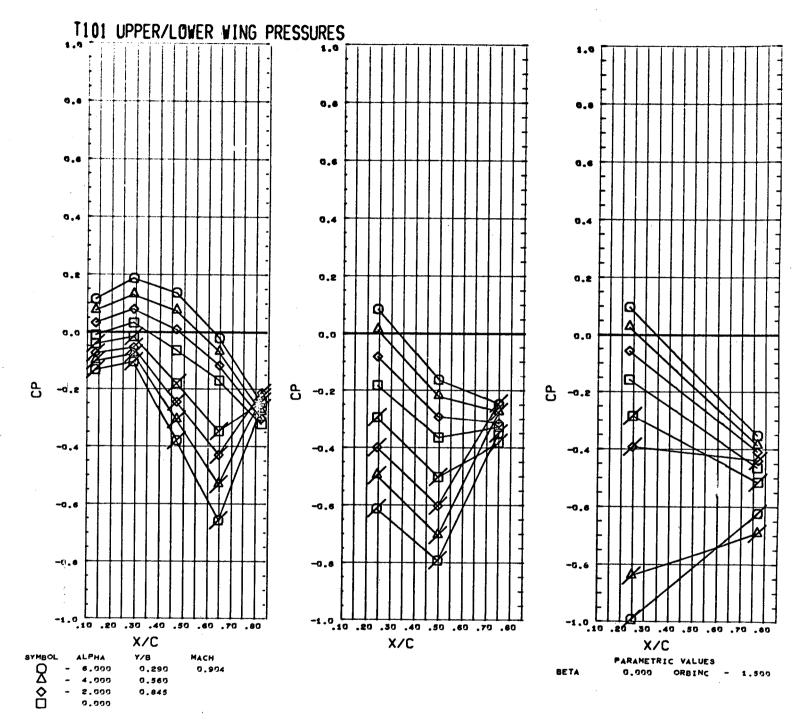
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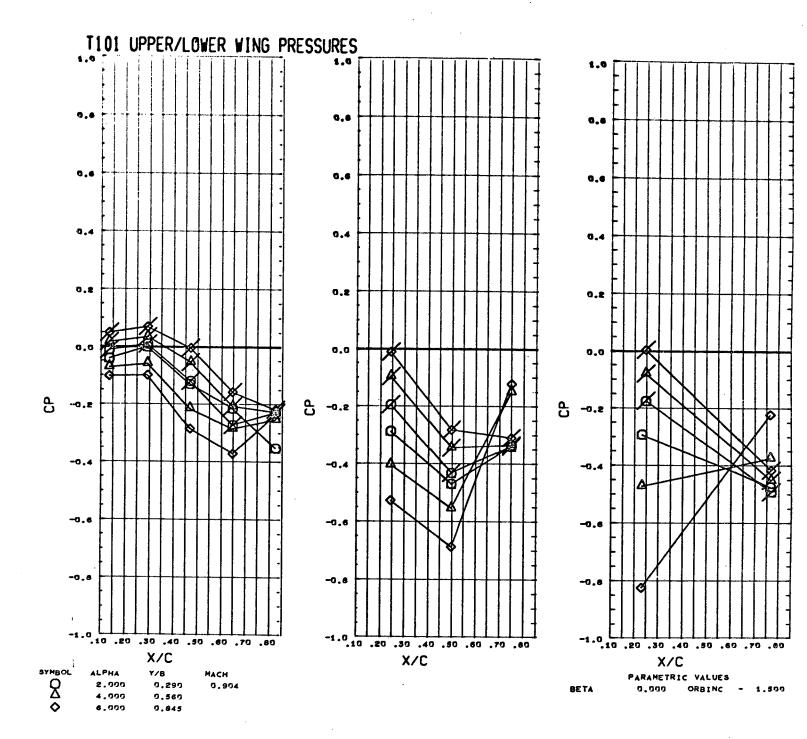
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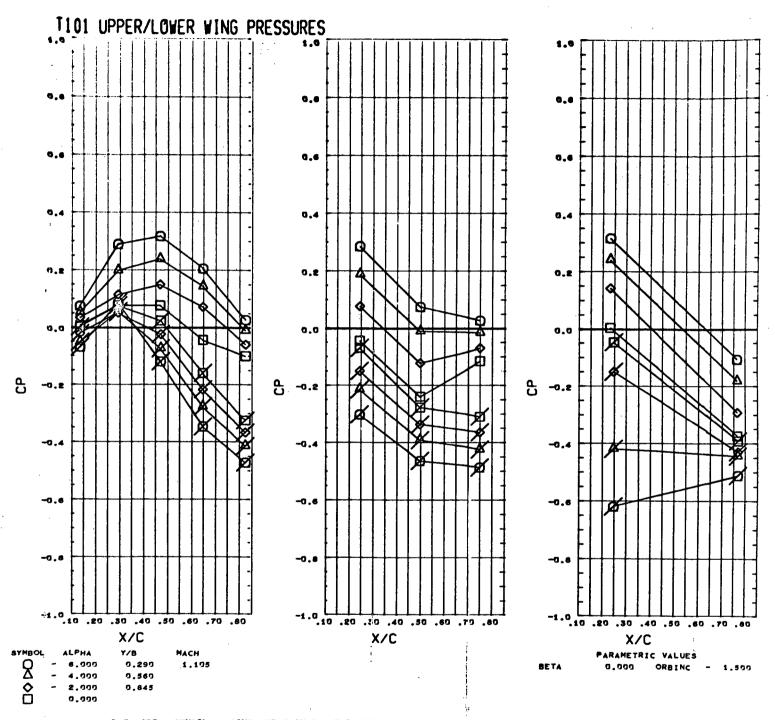
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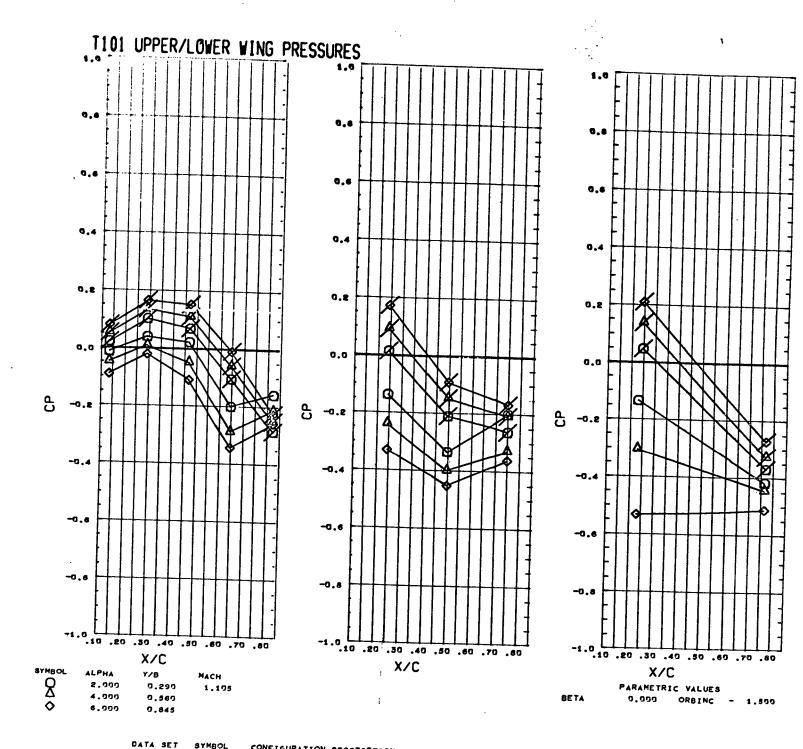


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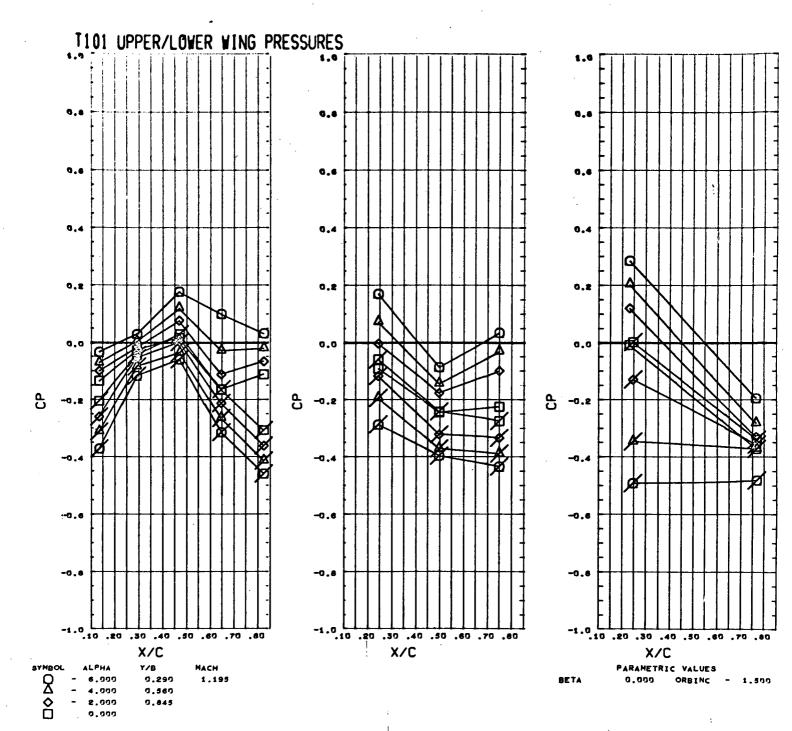


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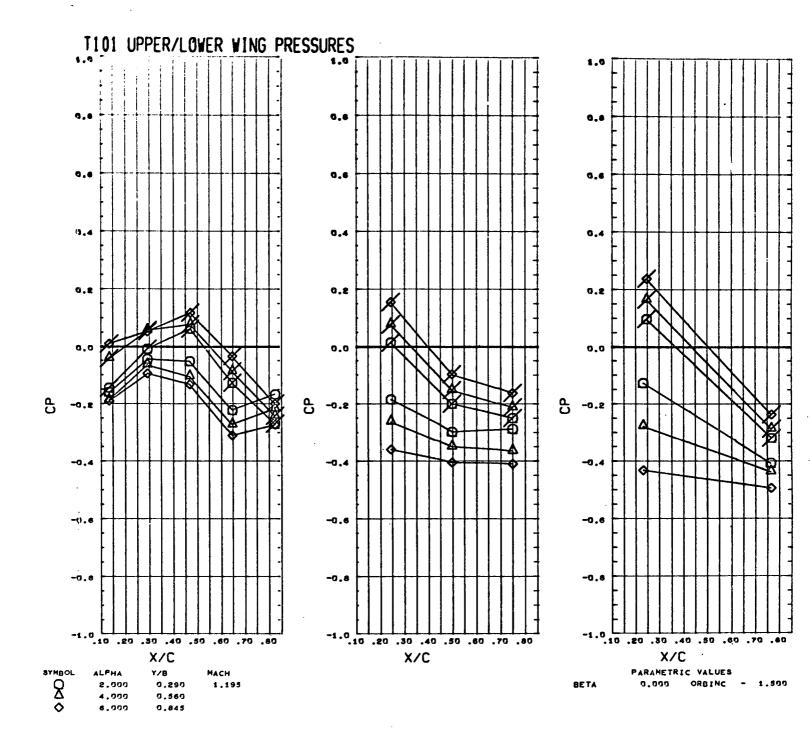
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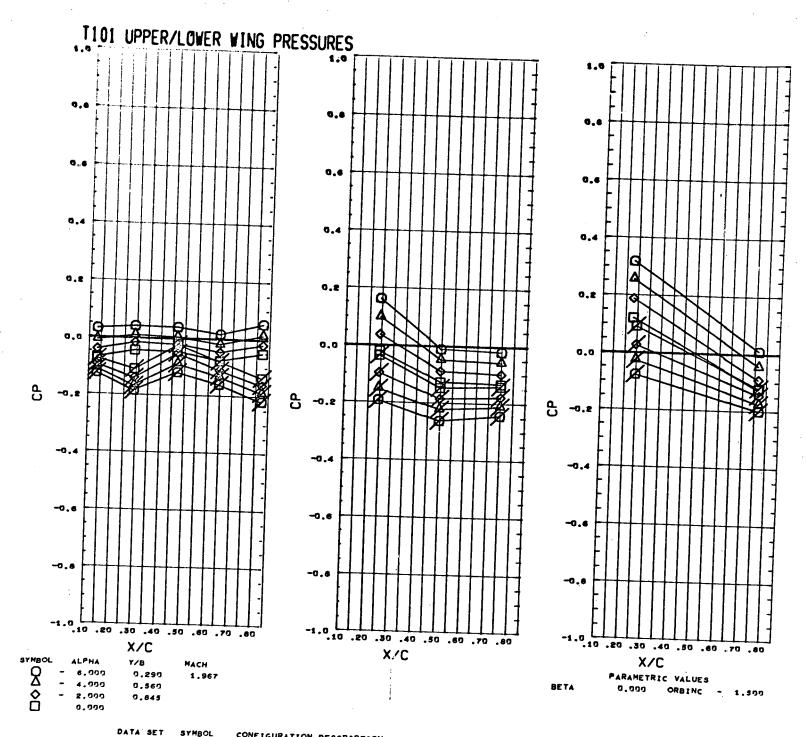
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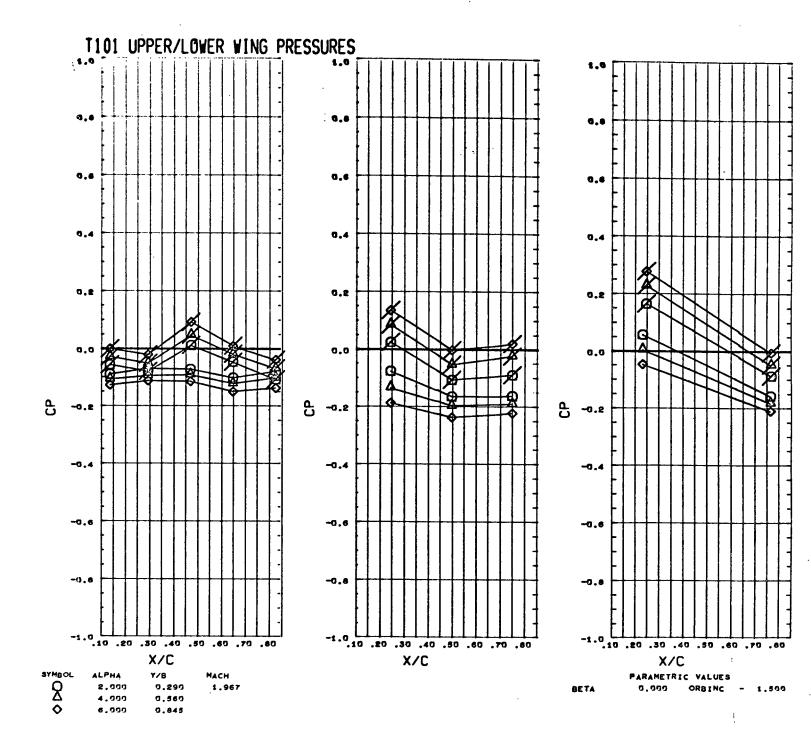
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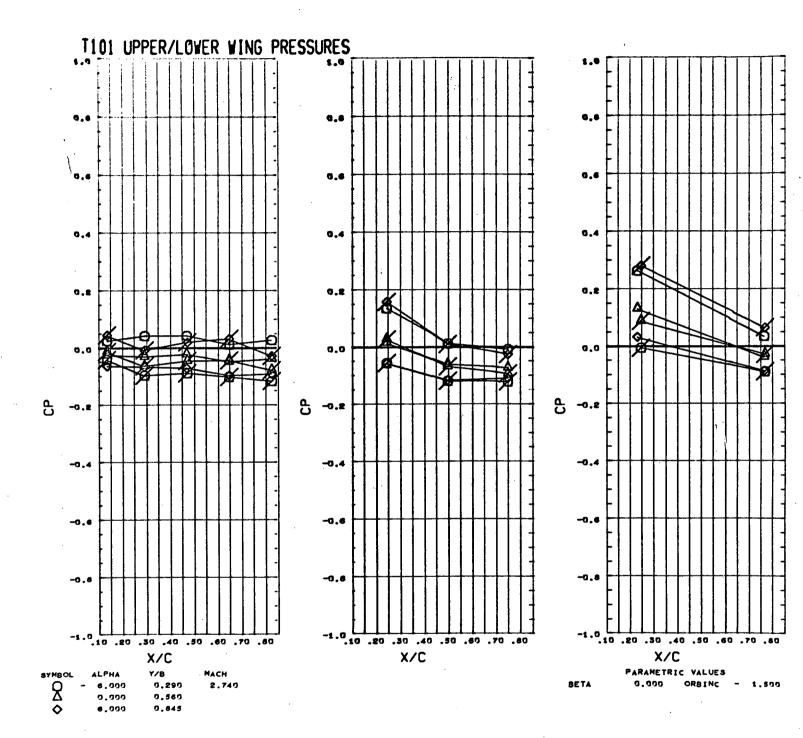
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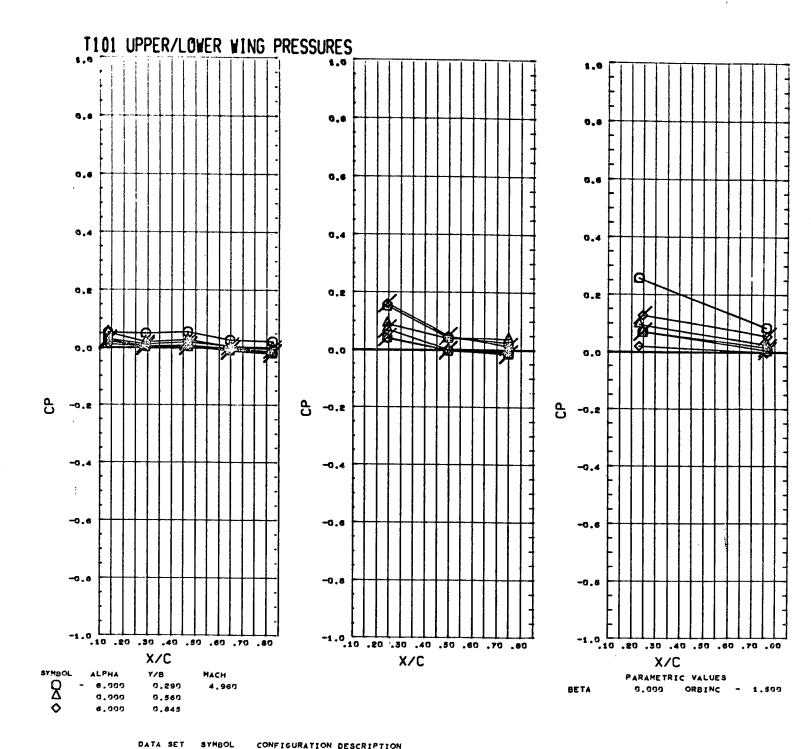


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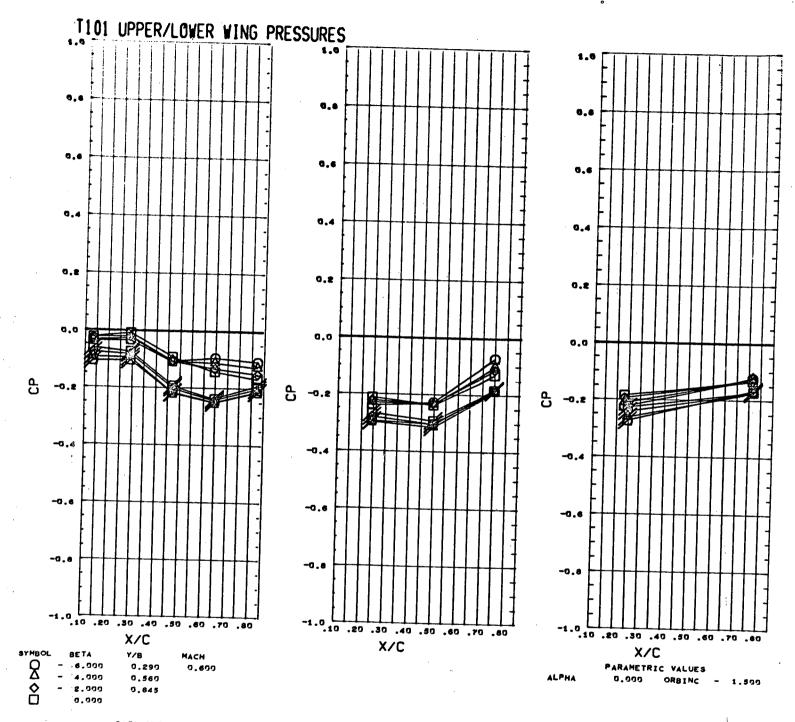


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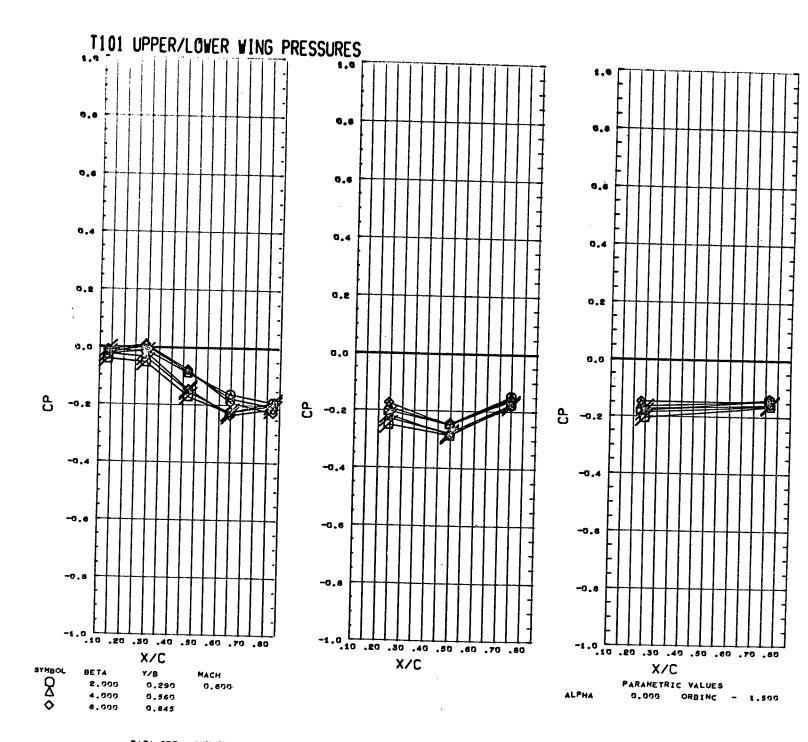
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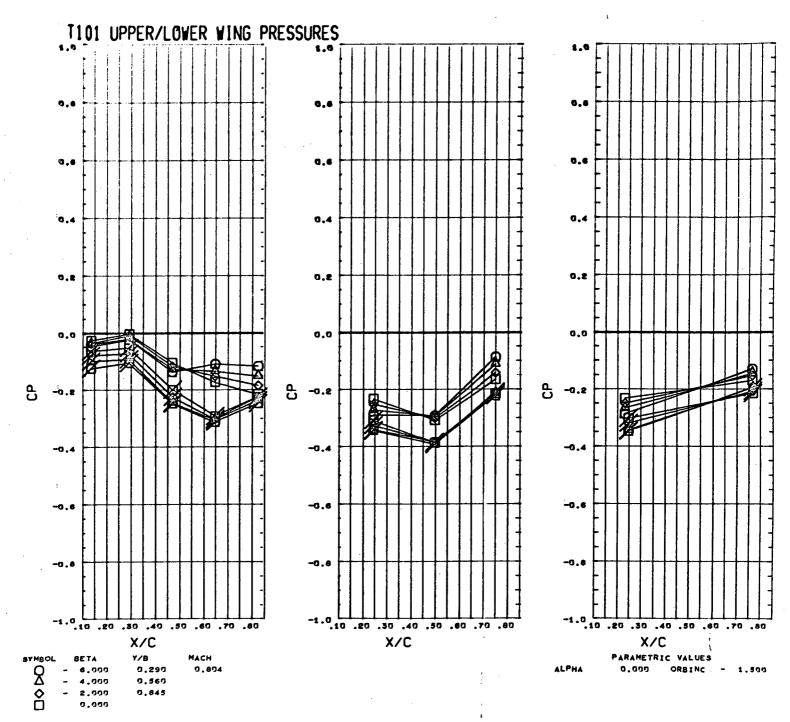


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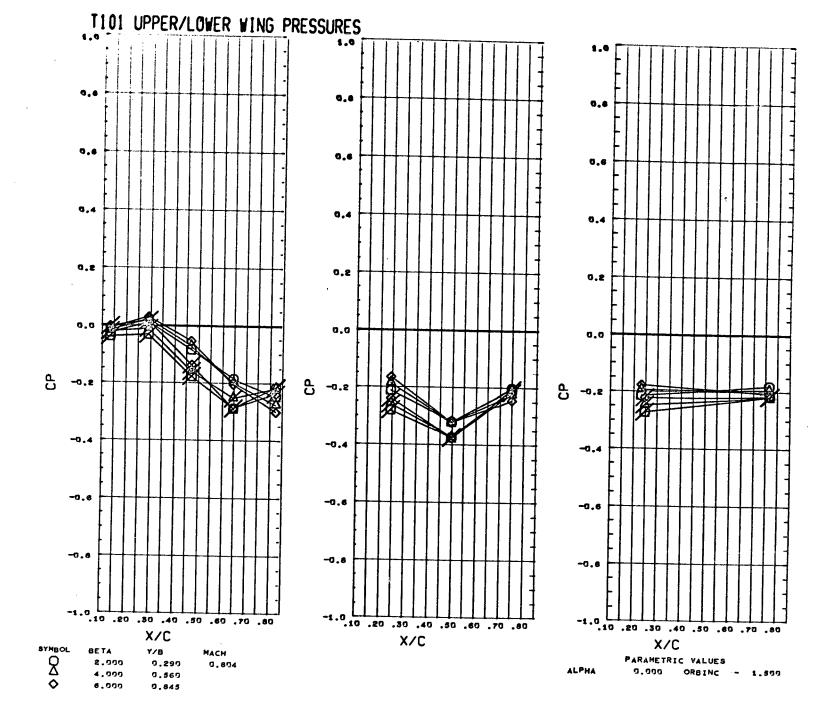


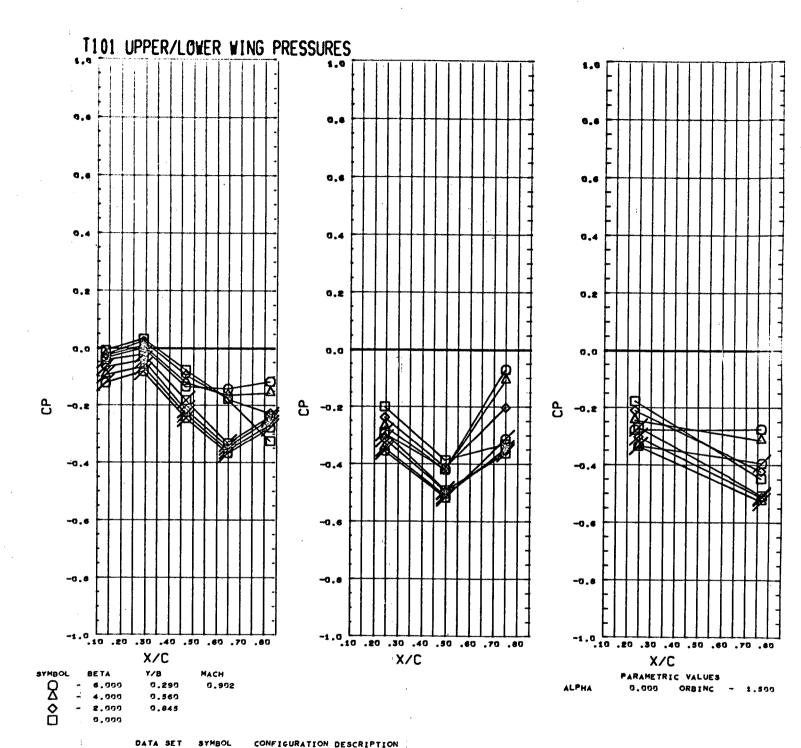
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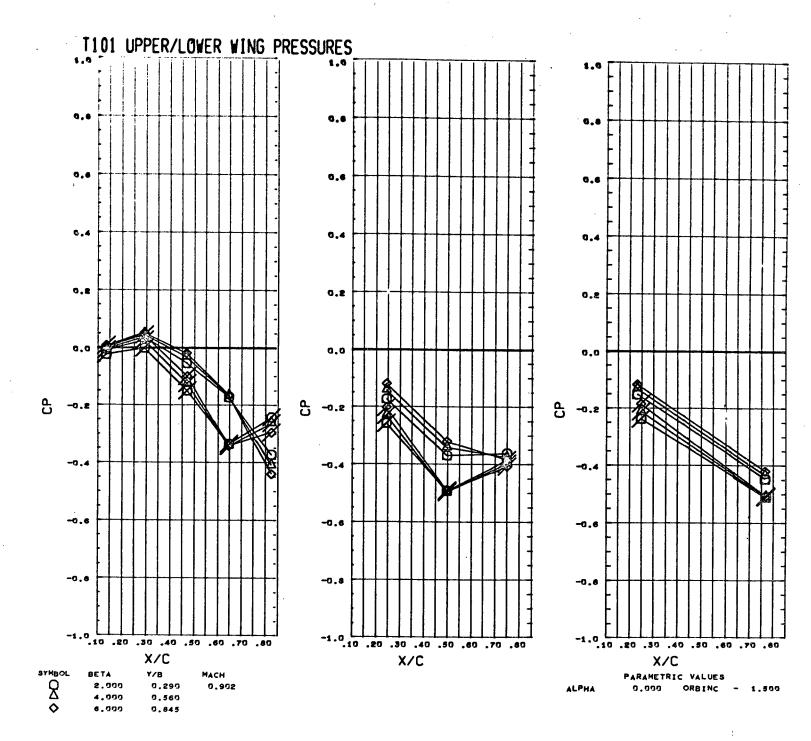


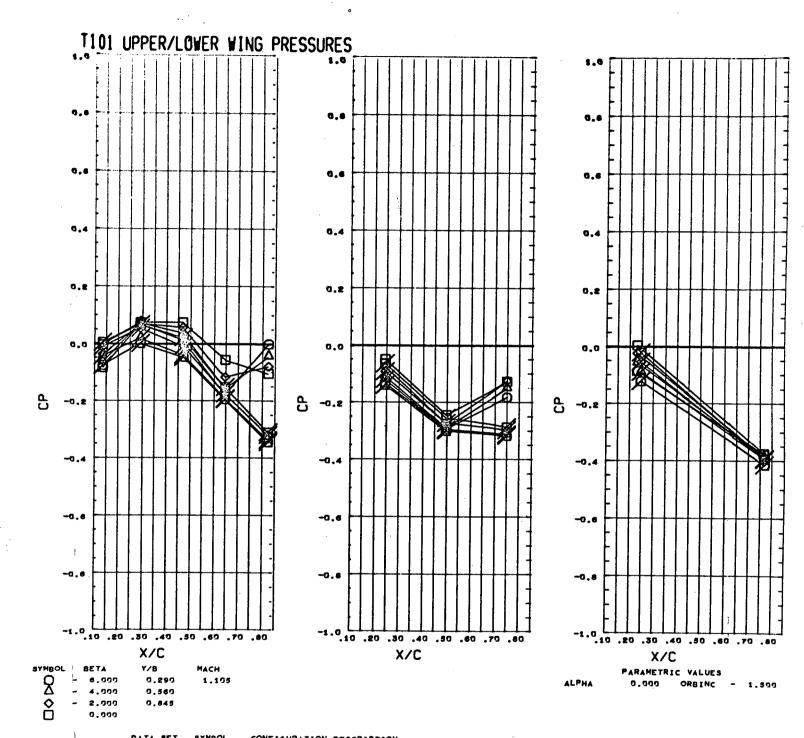






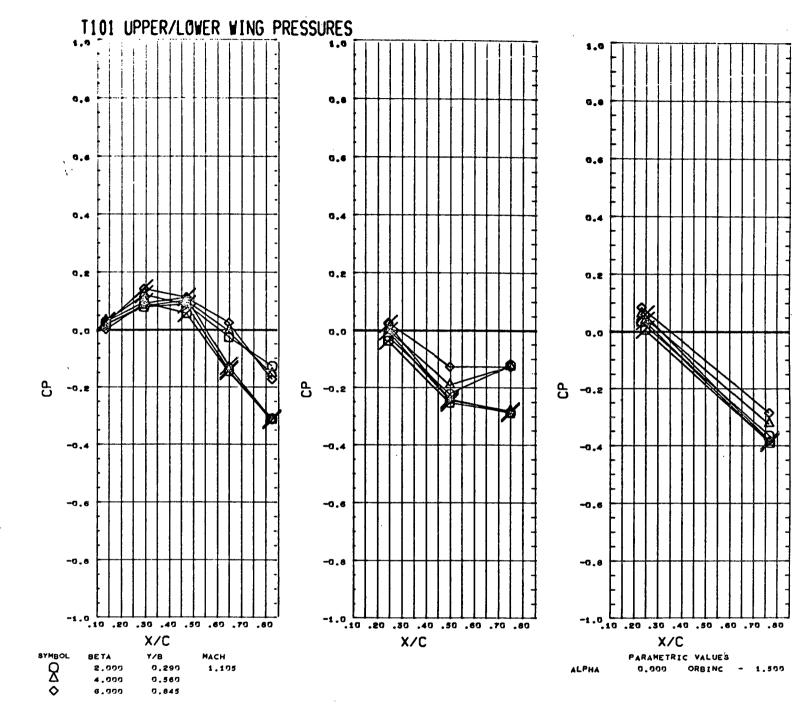
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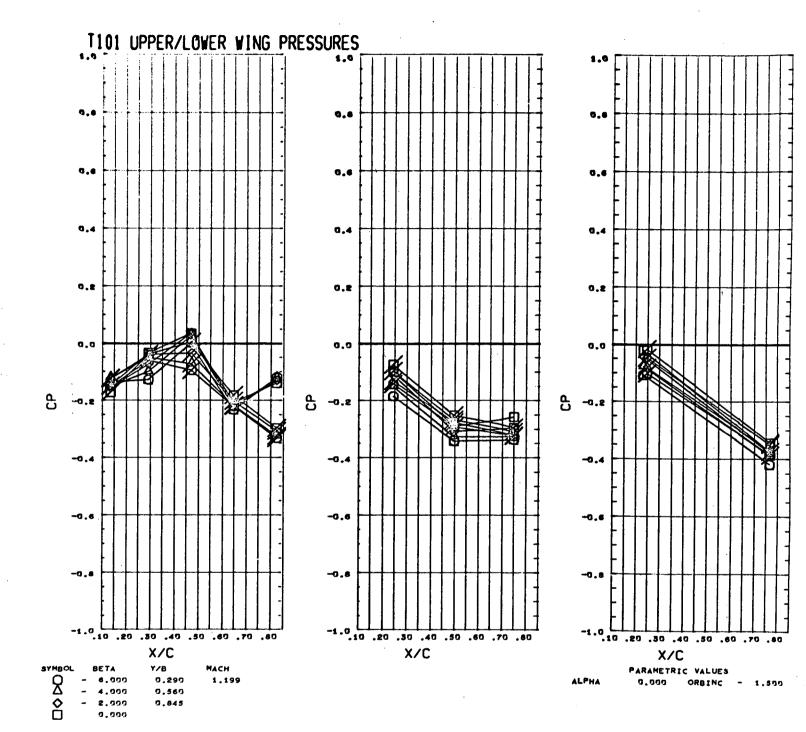


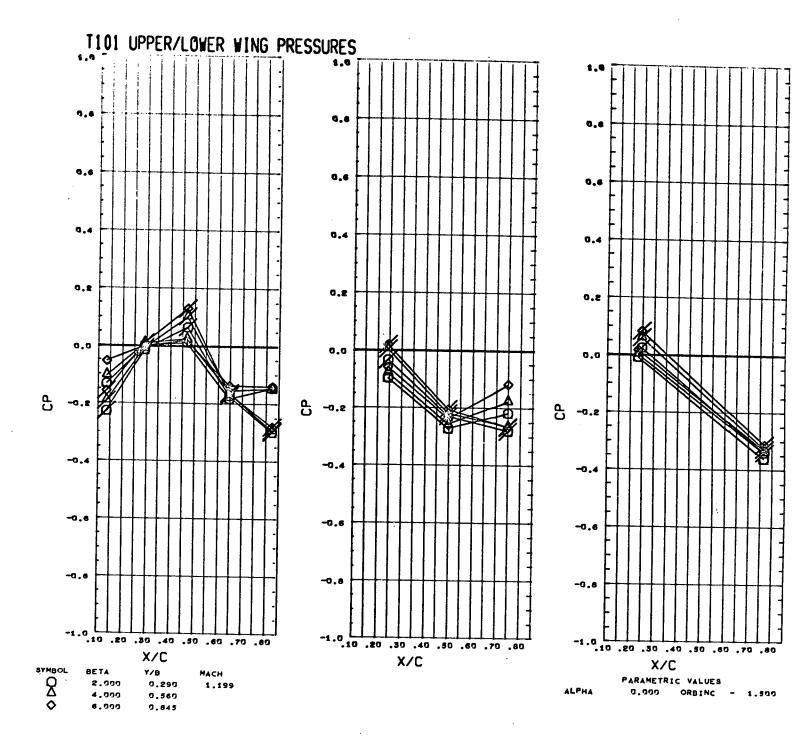


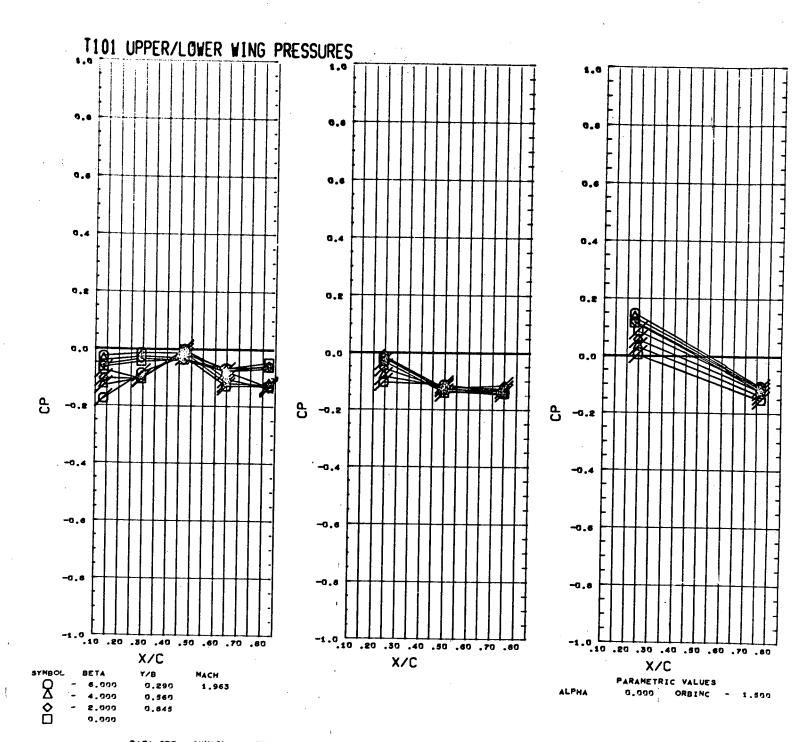
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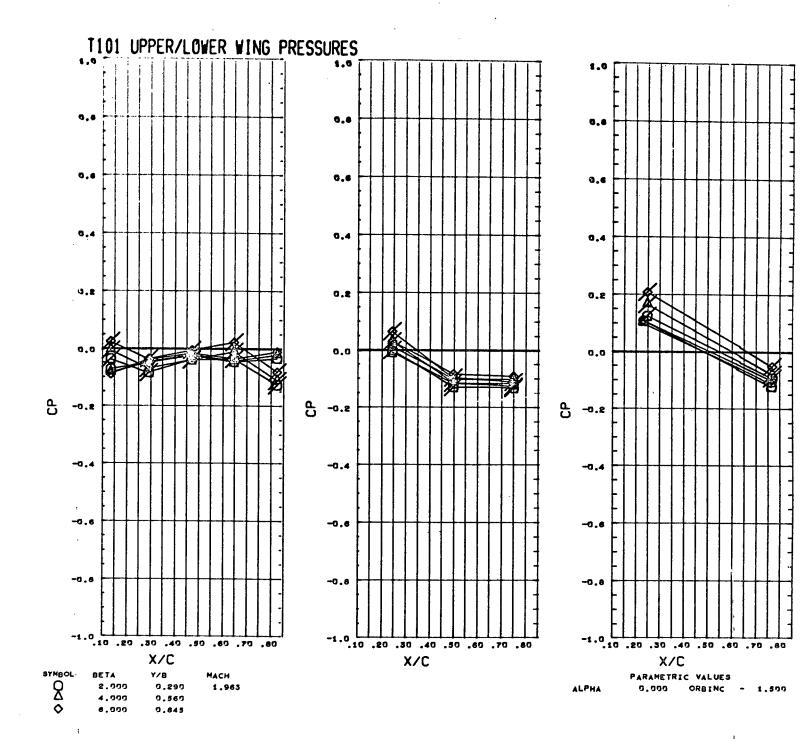
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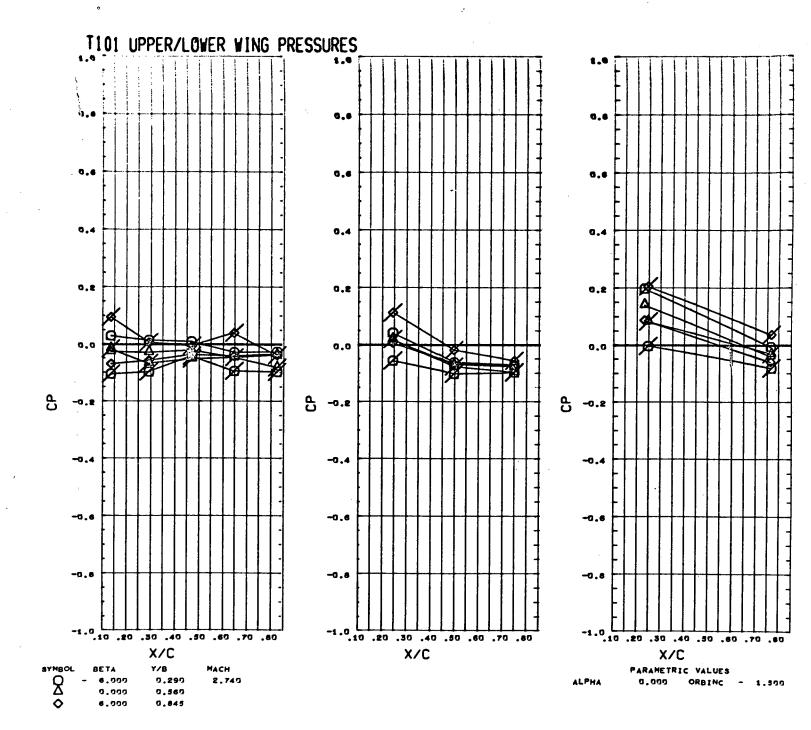


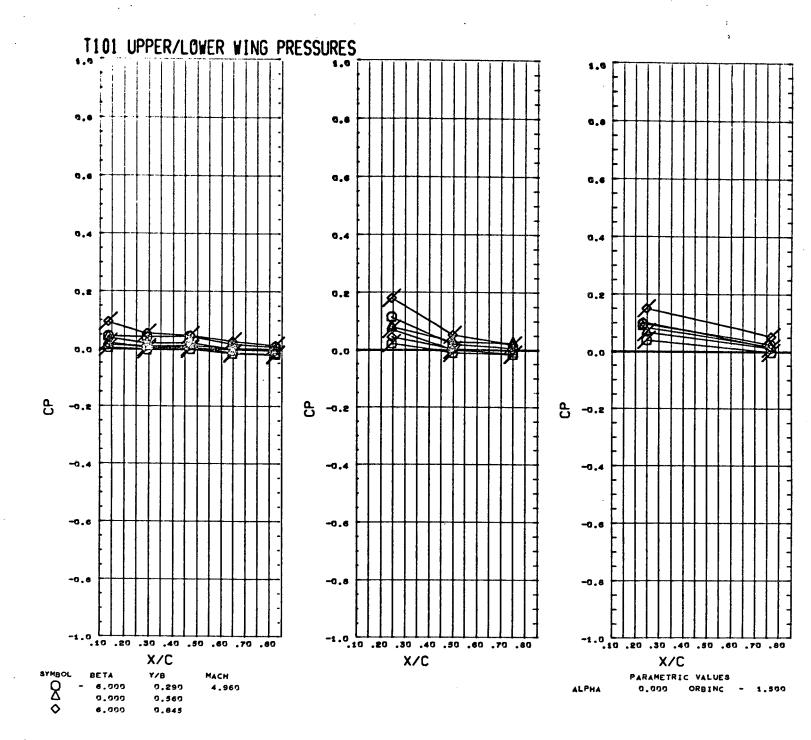


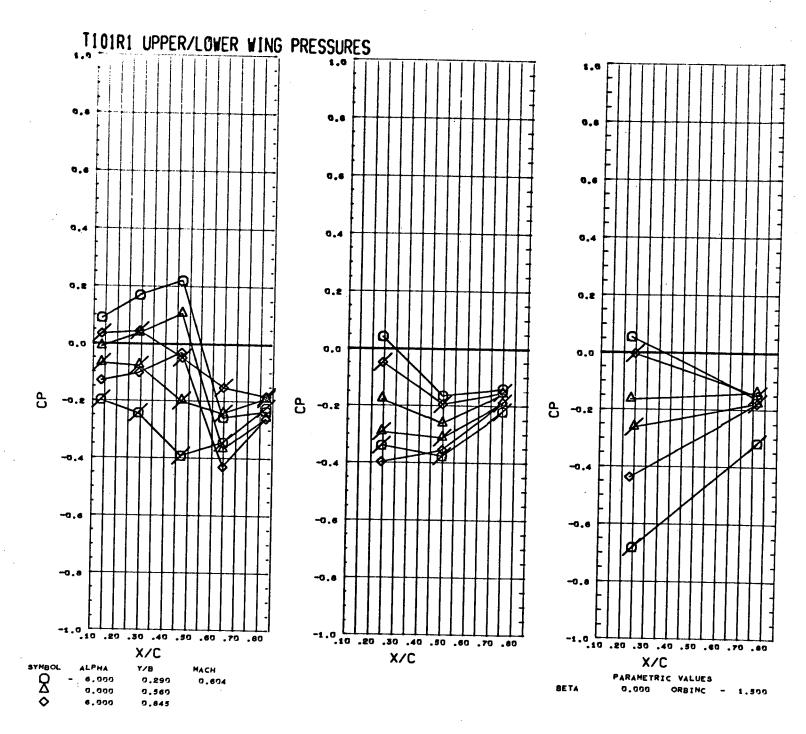


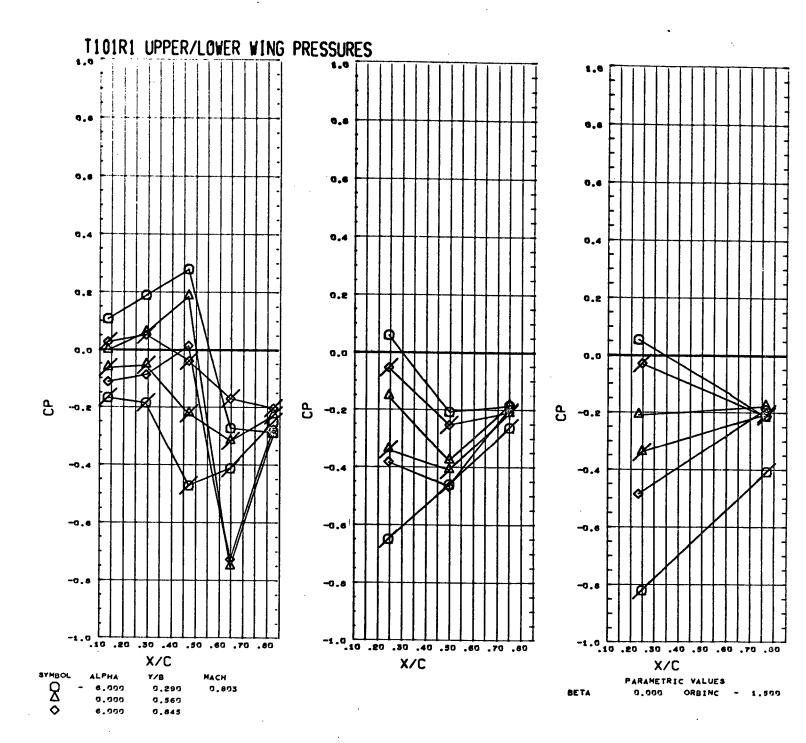


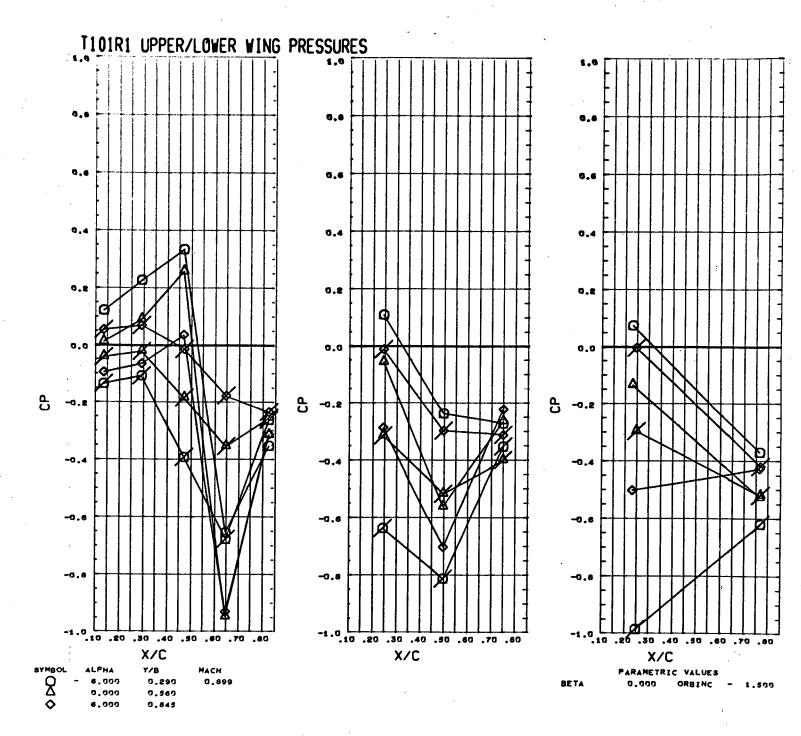


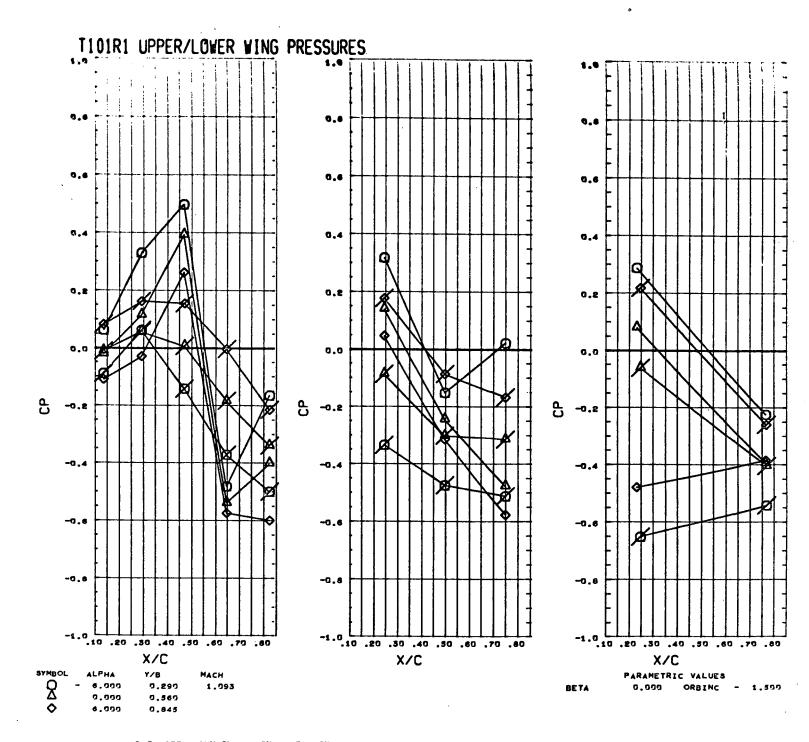


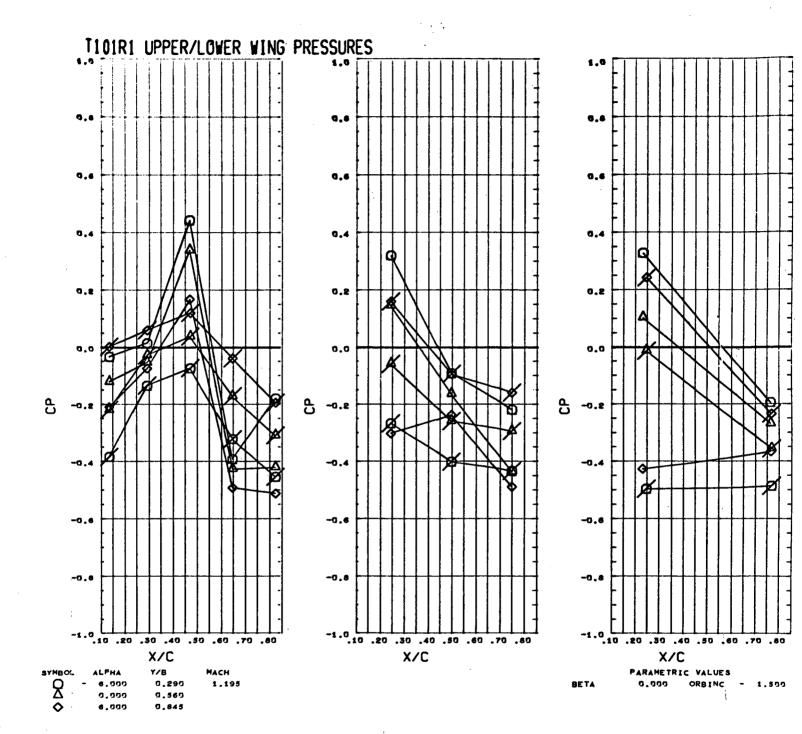


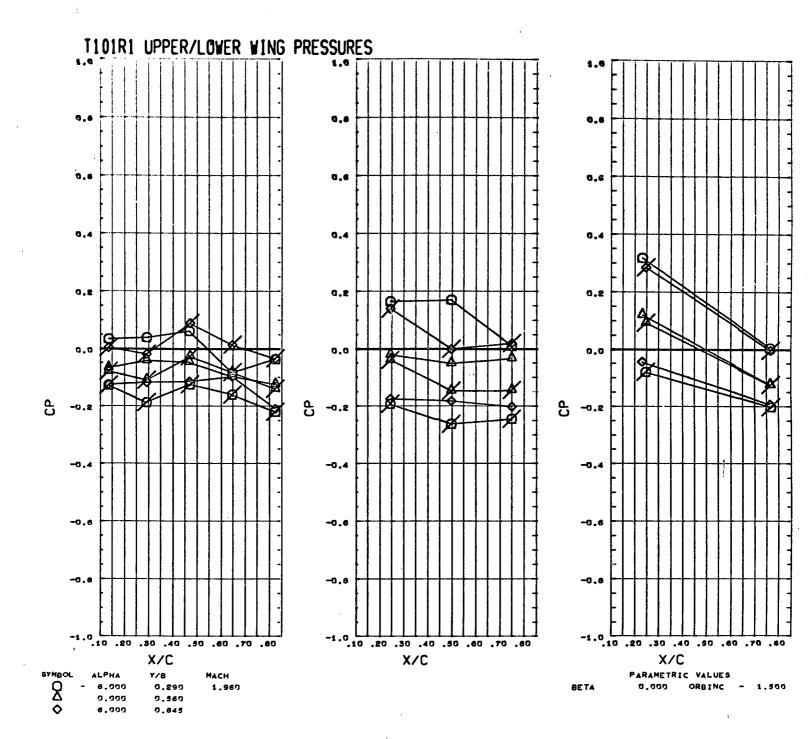




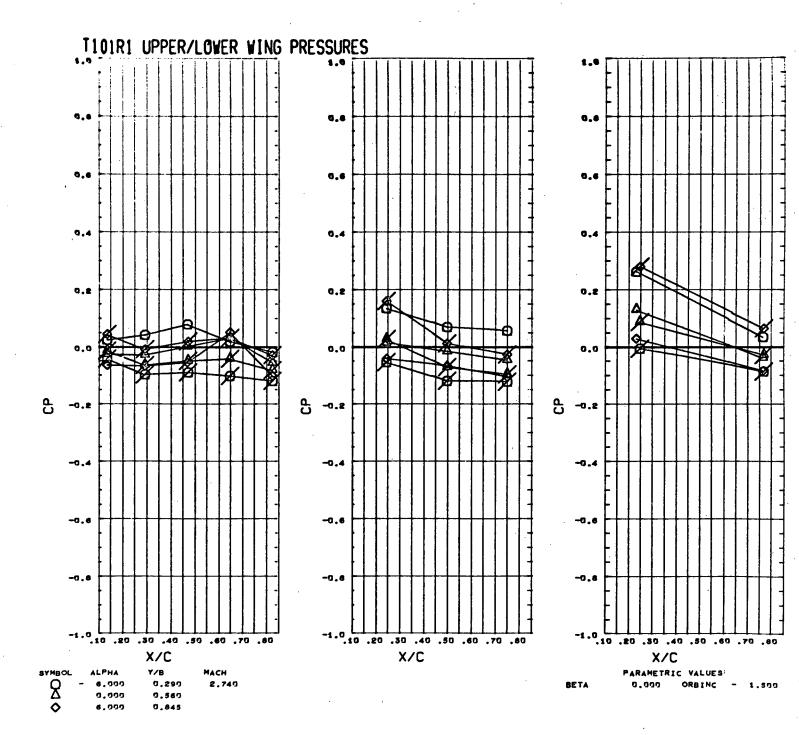


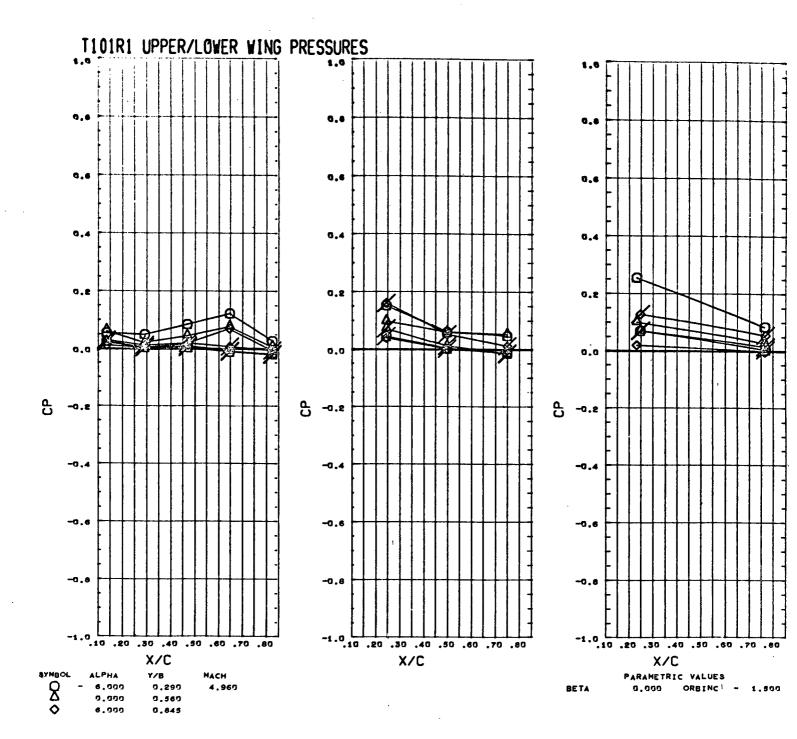


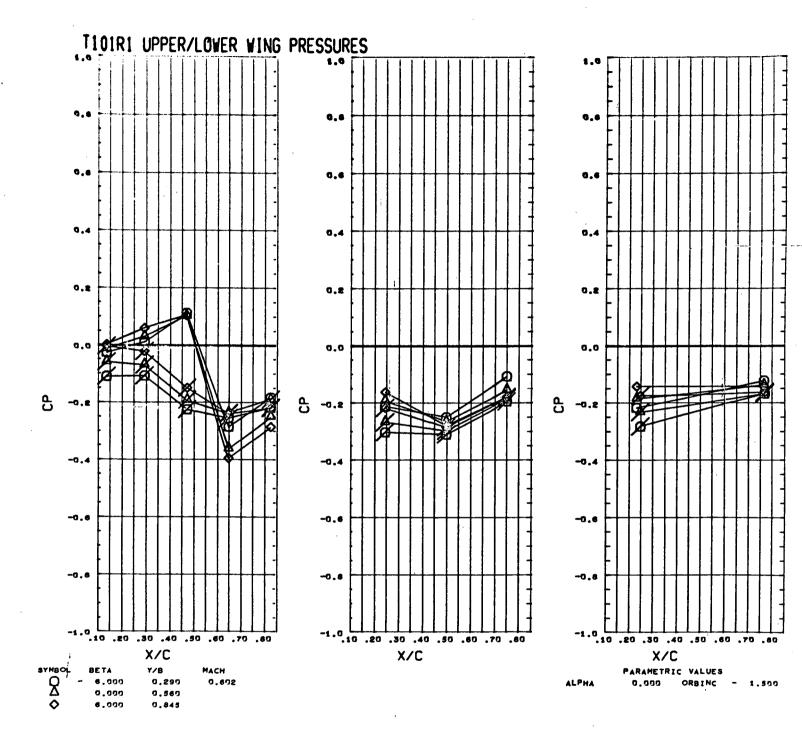


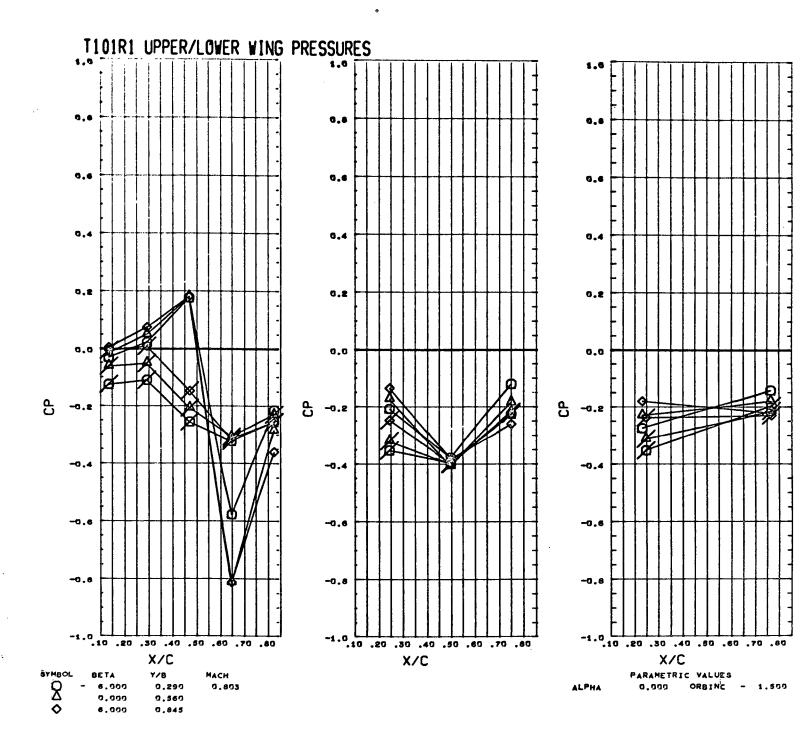


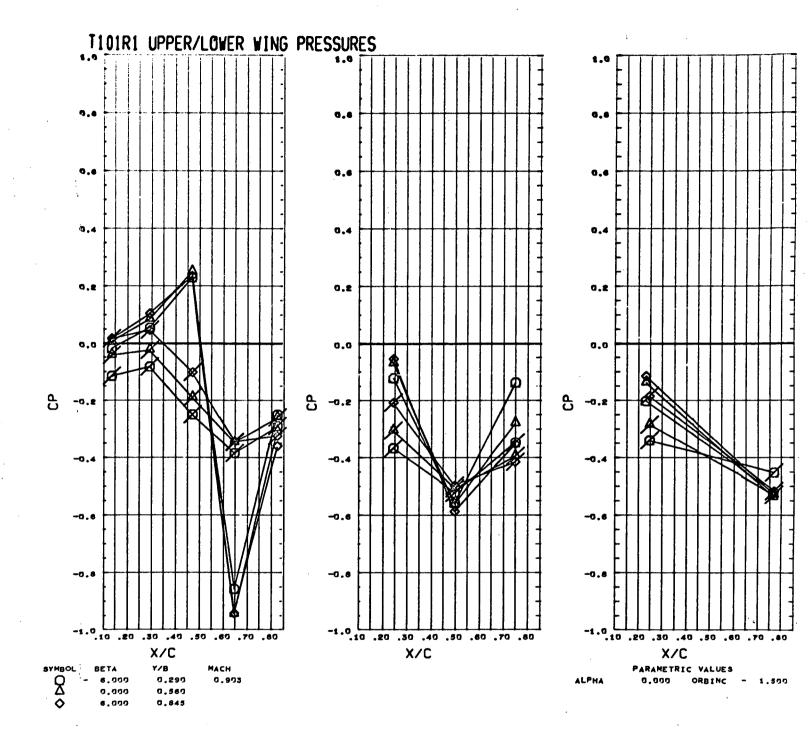
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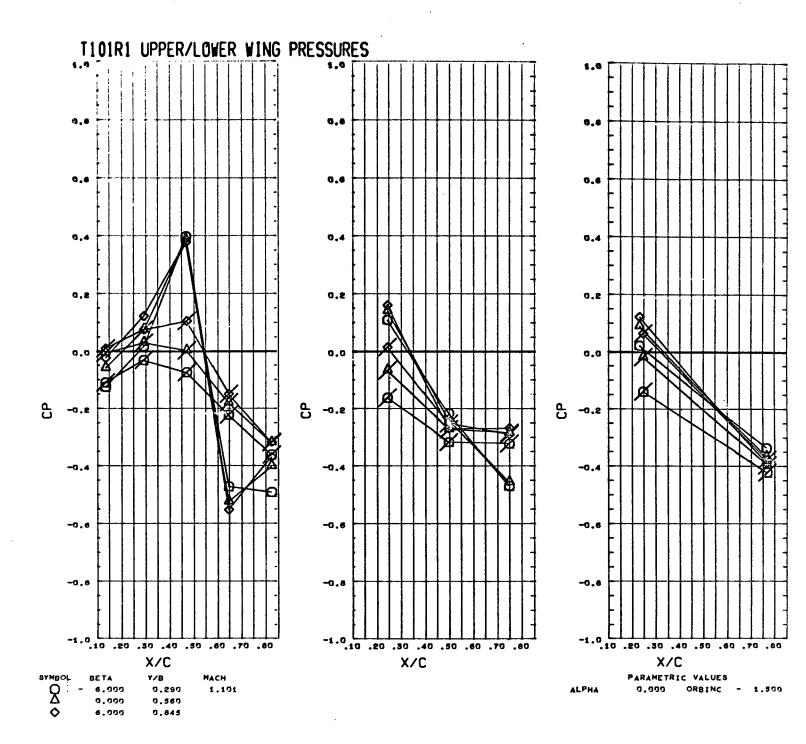


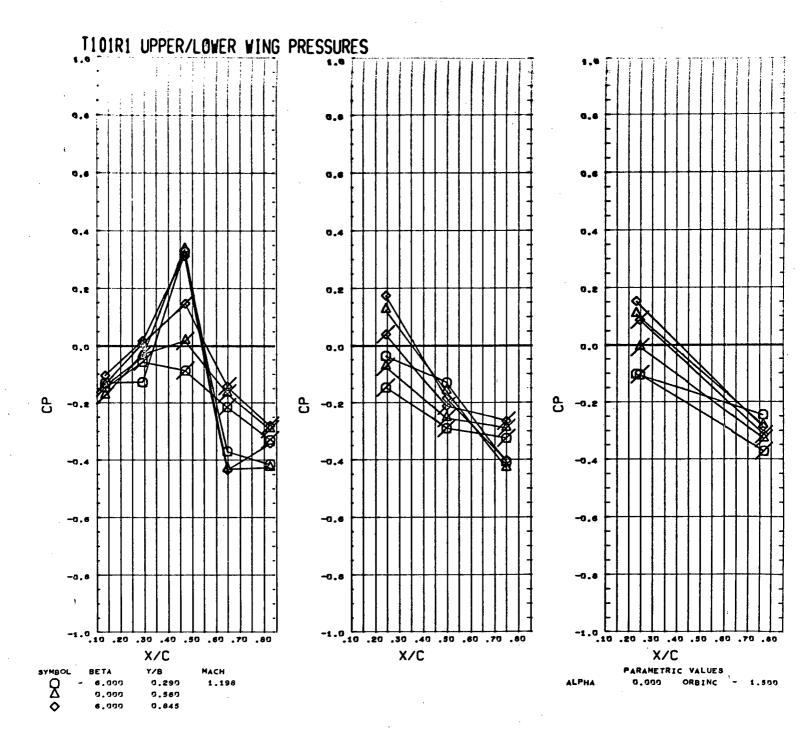


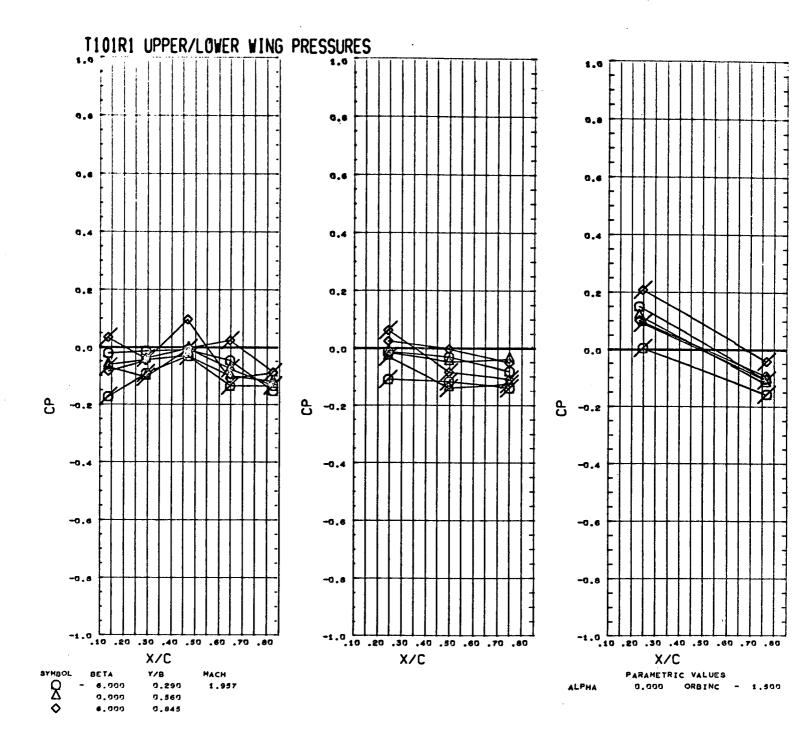


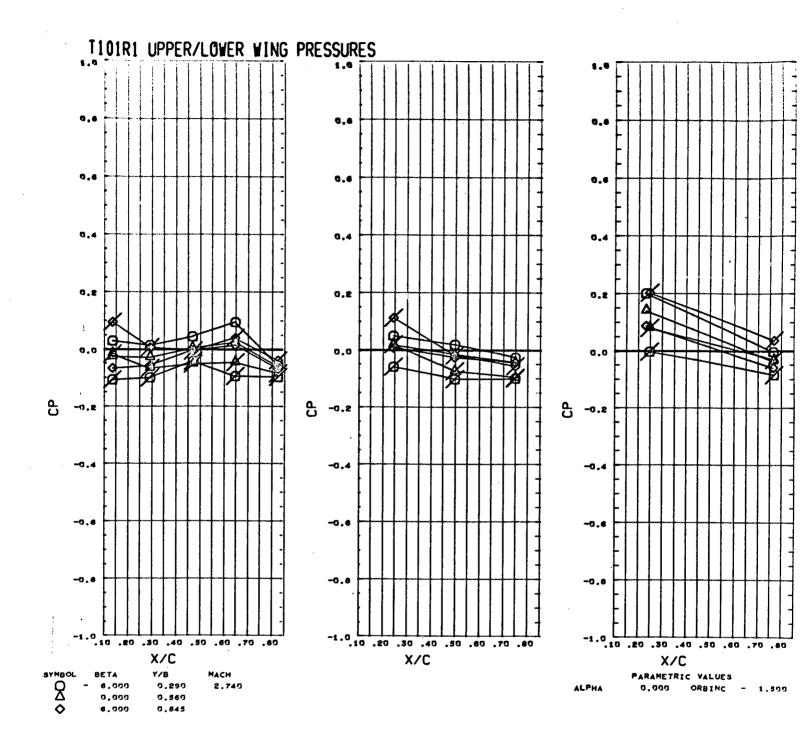


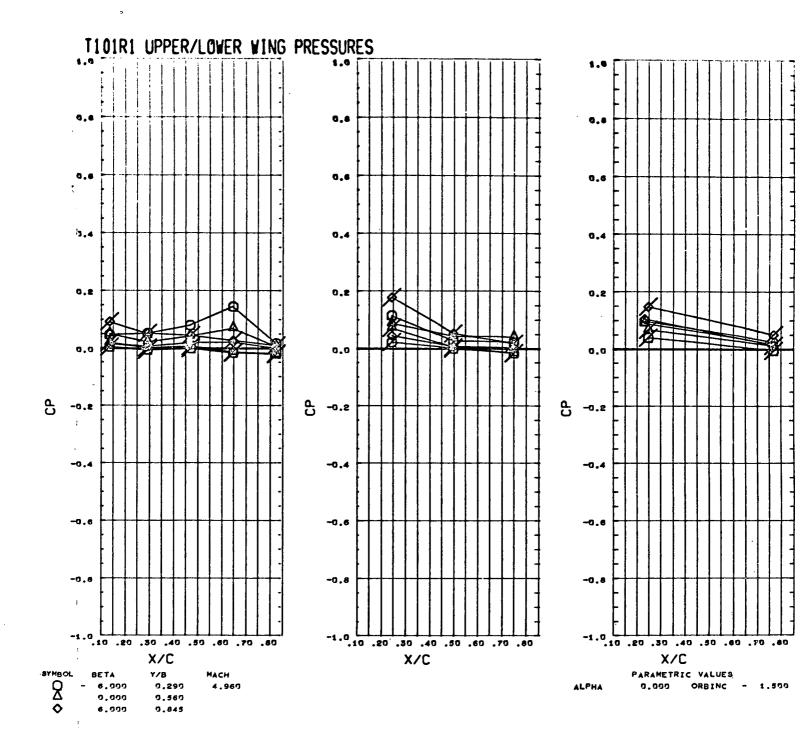


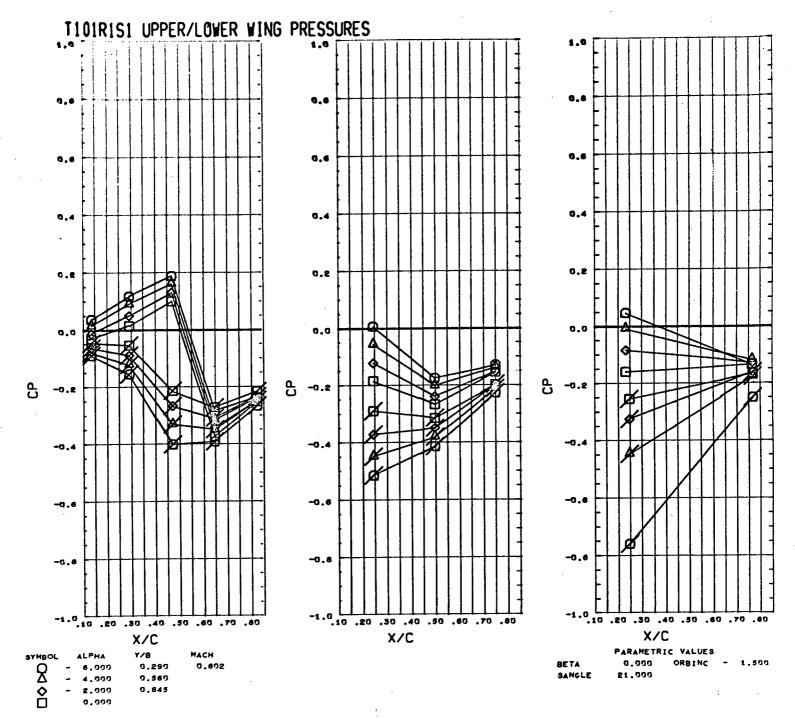


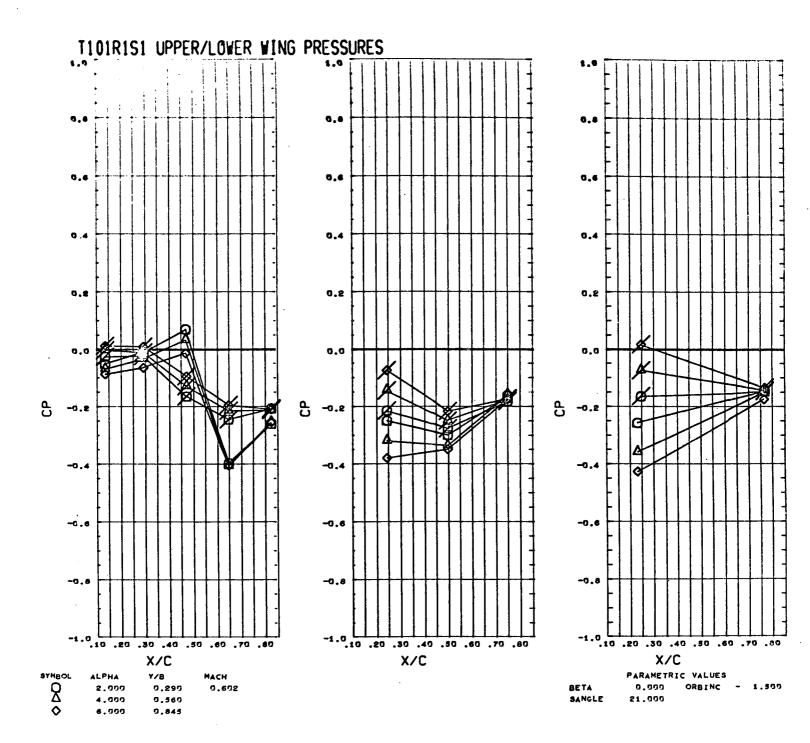


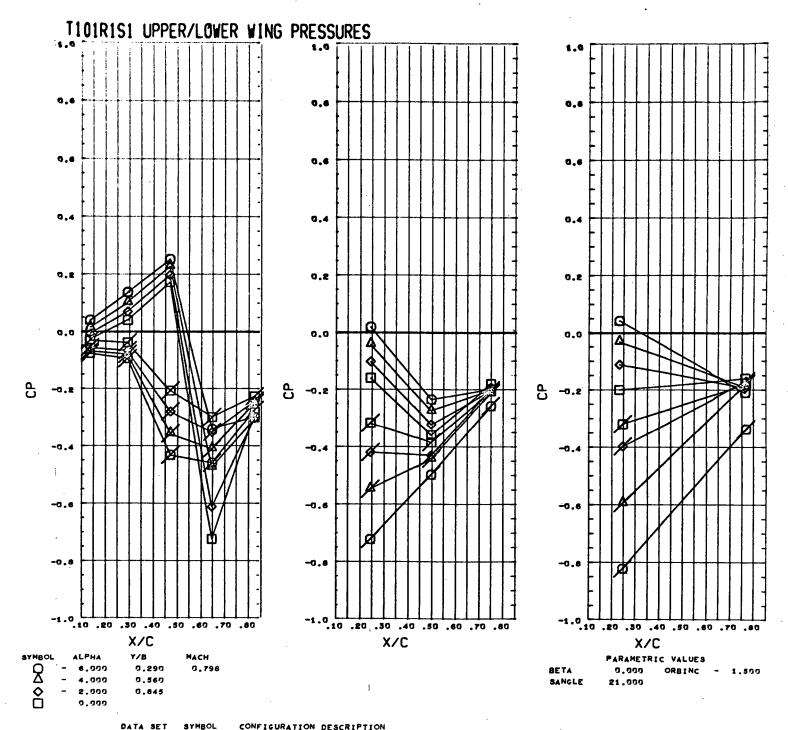


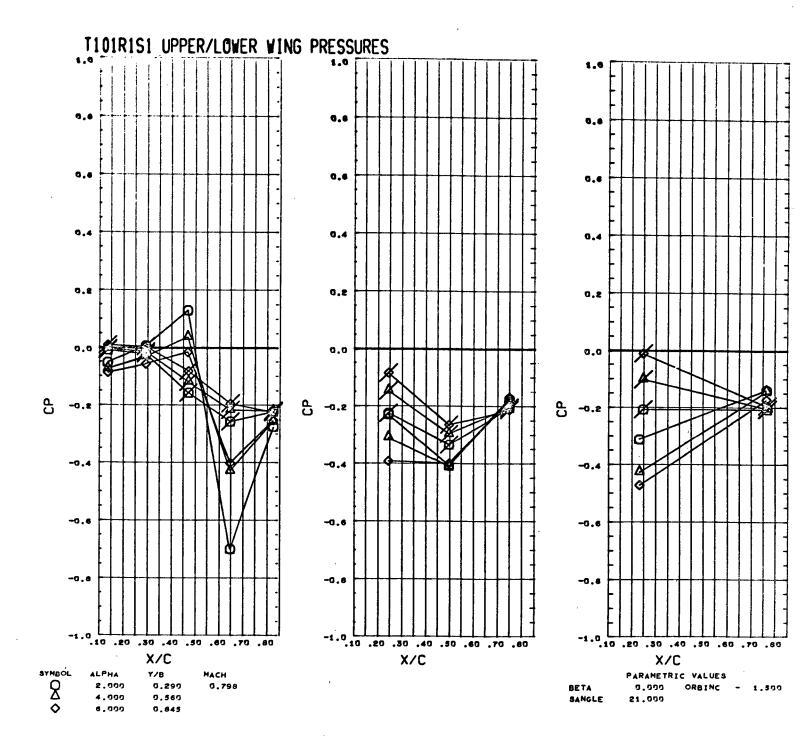


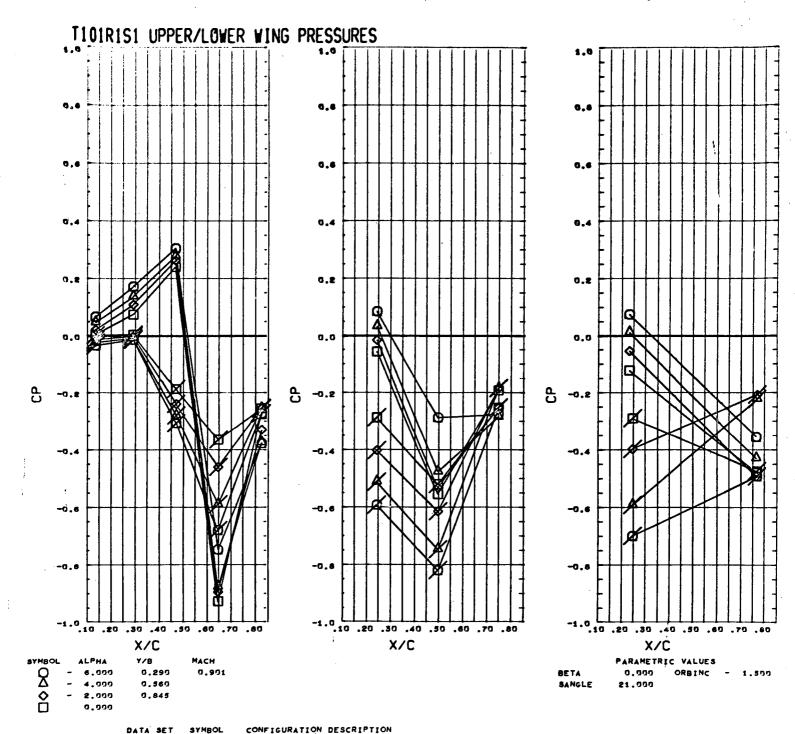




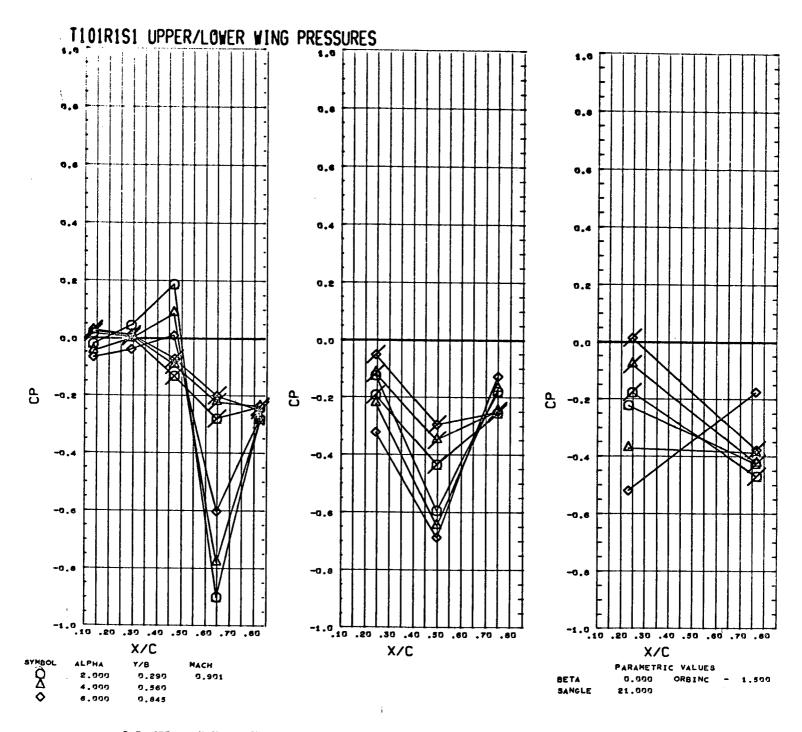


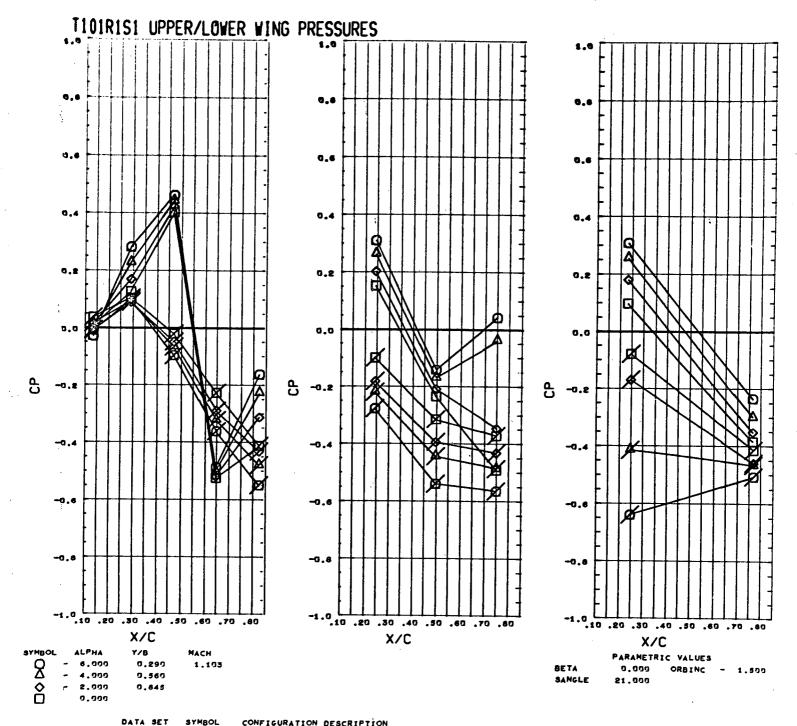


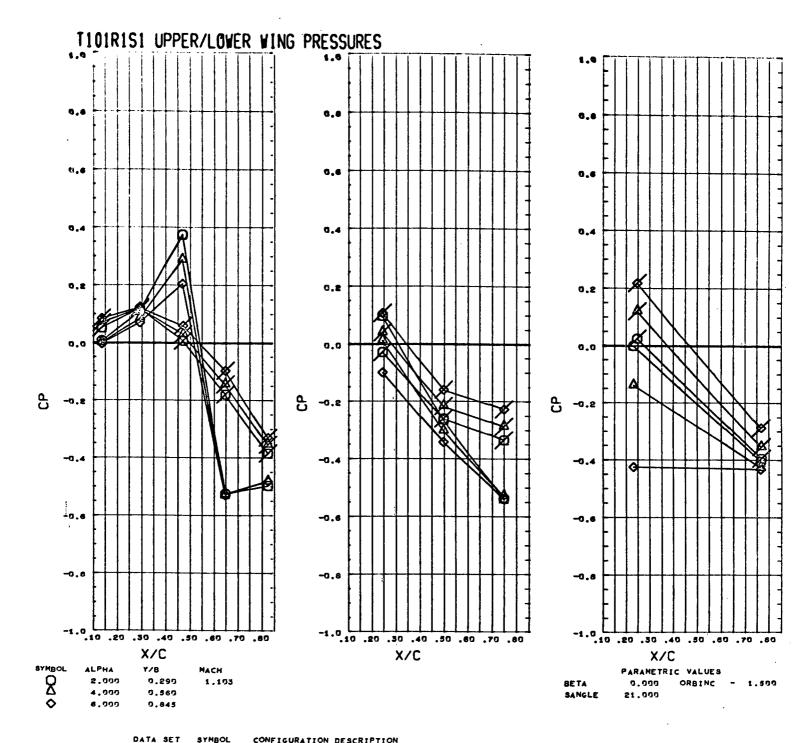




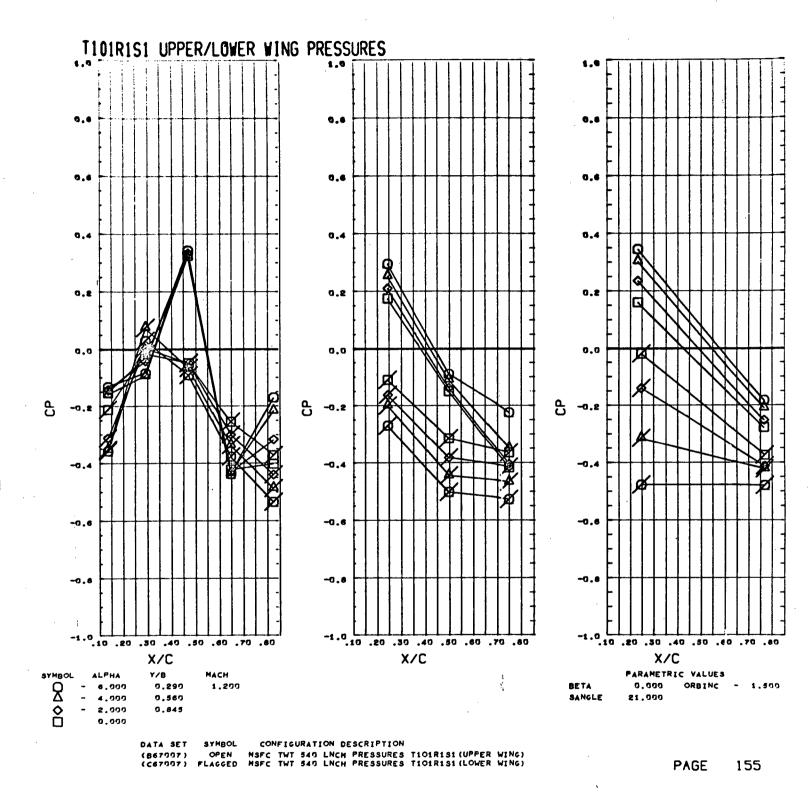
(867997) OPEN MSFC TWT 549 LNCH PRESSURES TIOIRISI (UPPER WING)
(C67997) FLAGGED MSFC TWT 549 LNCH PRESSURES TIOIRISI (LOWER WING)

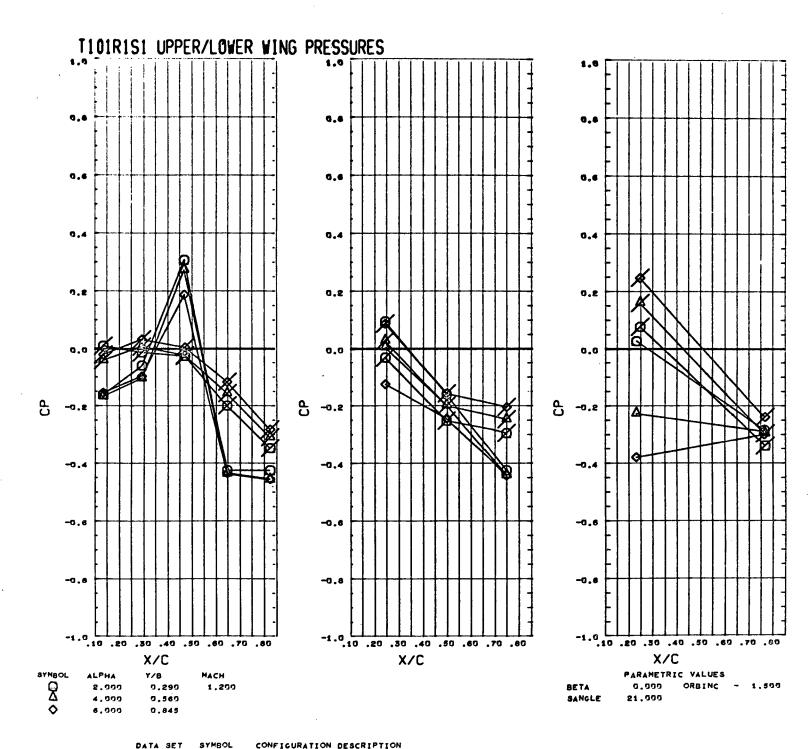




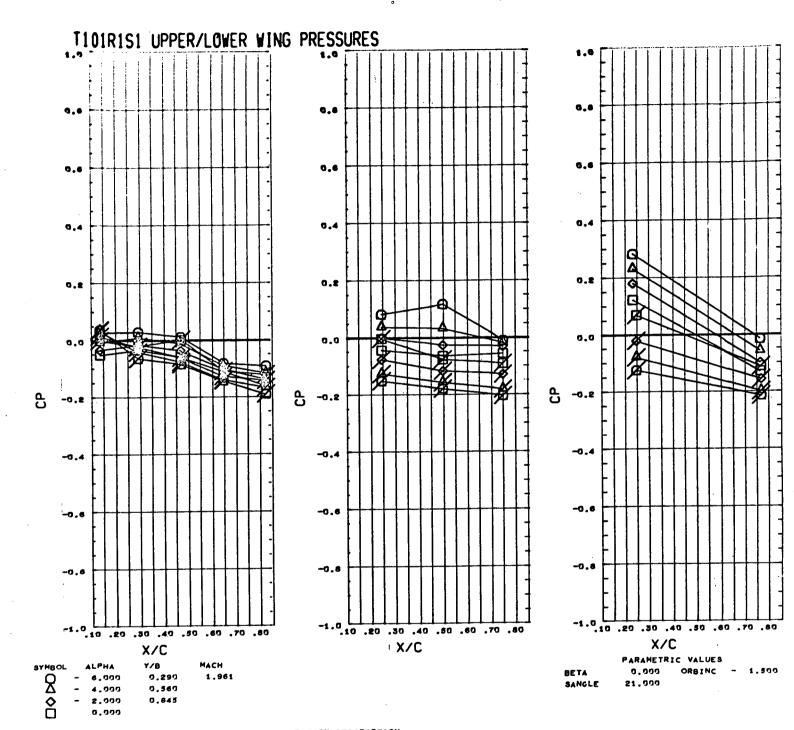


DATA SET SYMBOL CONFIGURATION DESCRIPTION
(867707) OPEN MSFC TWT 540 LNCH PRESSURES TIOIRISI (UPPER WING)
(C67707) FLAGGED MSFC TWT 540 LNCH PRESSURES TIOIRISI (LOWER WING)





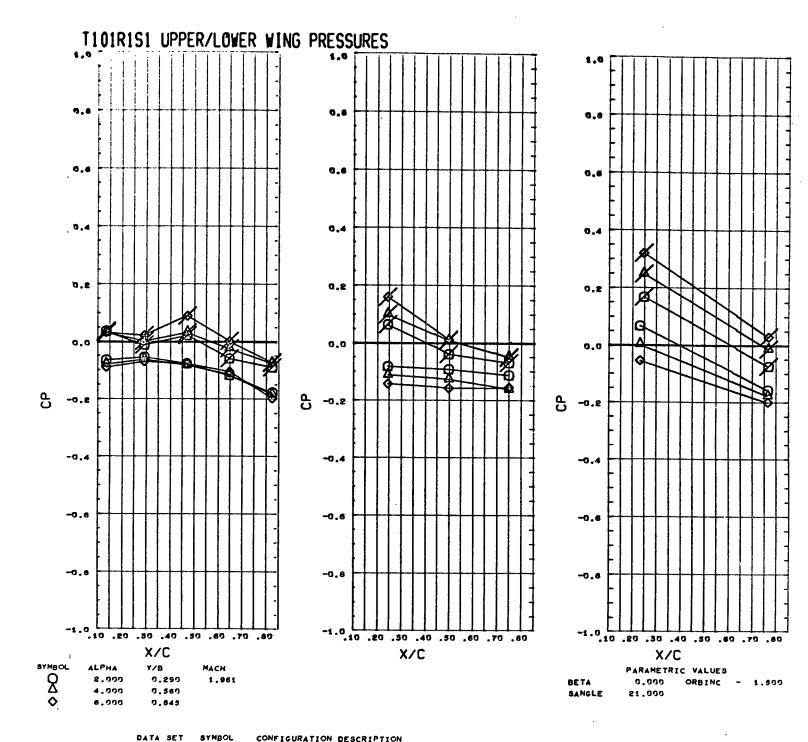
DATA SET SYMBOL CONFIGURATION DESCRIPTION
(867007) OPEN MSFC TWT 540 LNCH PRESSURES TIO1RISI(UPPER WING)
(C67007) FLAGGED MSFC TWT 540 LNCH PRESSURES TIO1RISI(LOWER WING)



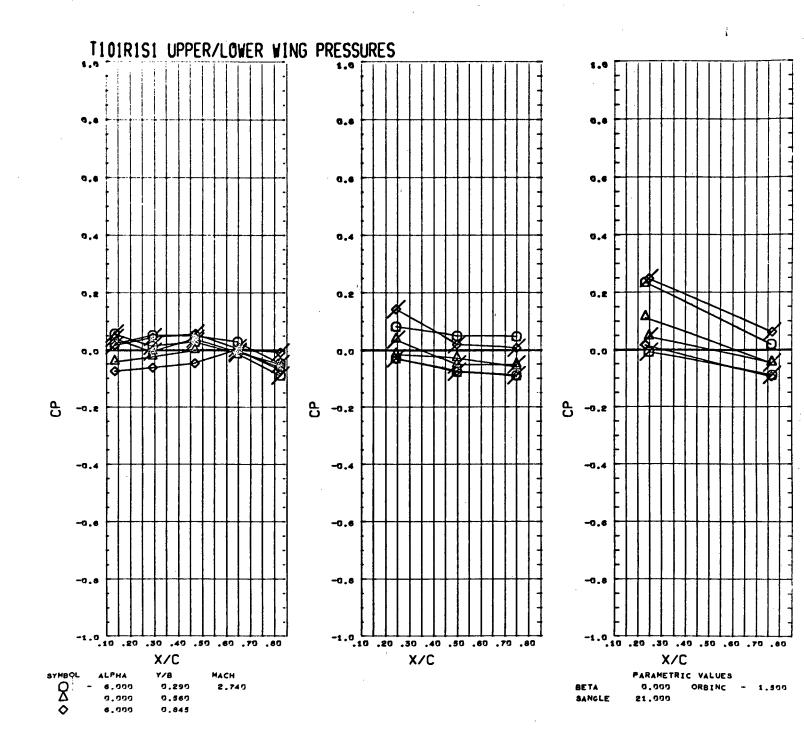
DATA SET SYMBOL CONFIGURATION DESCRIPTION

(867007) OPEN HSFC TWT 540 LNCH PRESSURES T101R131 (UPPER WING)

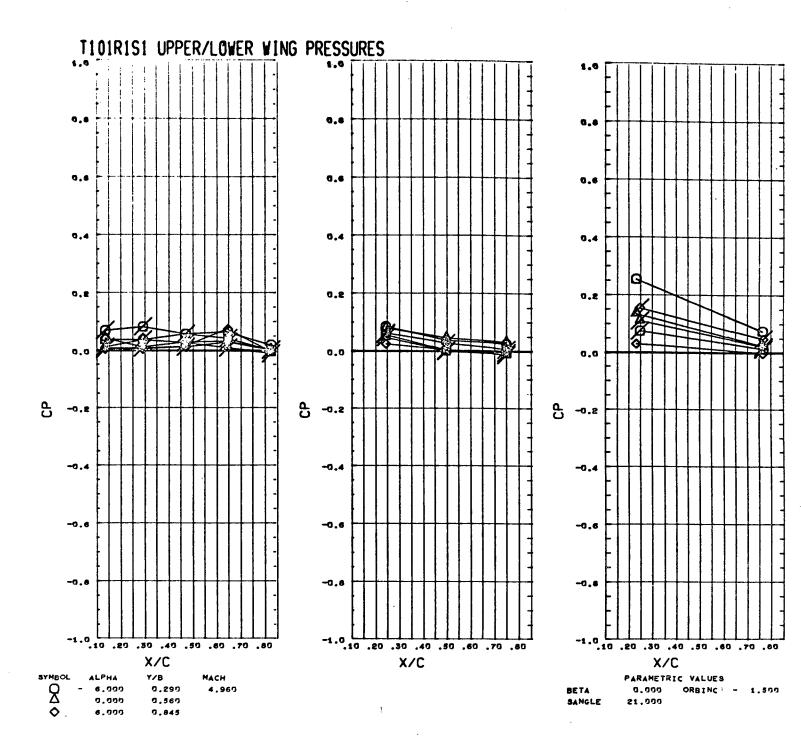
(C67007) FLAGGED HSFC TWT 540 LNCH PRESSURES T101R131 (LOWER WING)



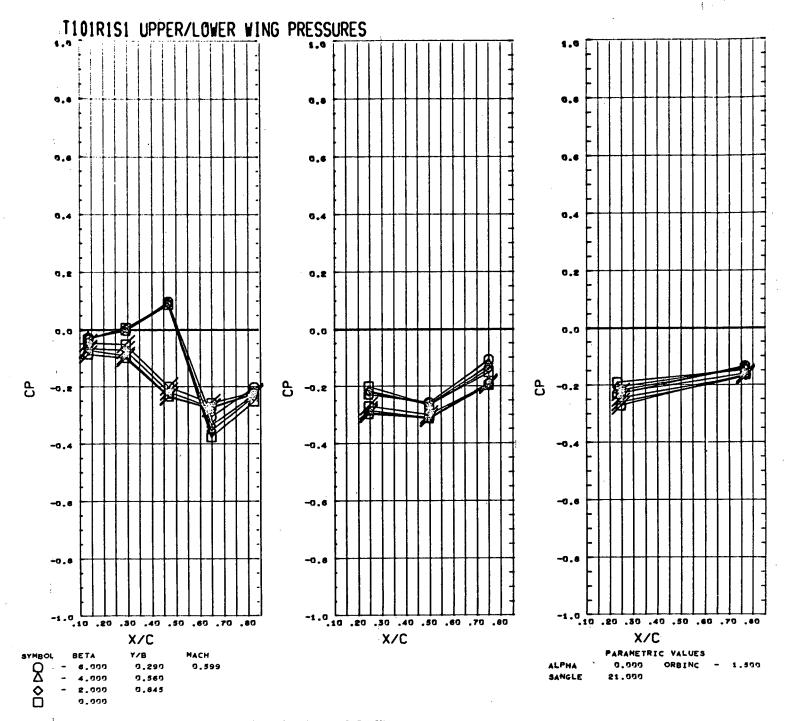
DATA SET SYMBOL CONFIGURATION DESCRIPTION
(867907) OPEN MSFC TWT 549 LNCH PRESSURES TIO1RIS1 (UPPER WING)
(C67907) FLAGGED MSFC TWT 549 LNCH PRESSURES TIO1RIS1 (LOWER WING)



DATA SET SYMBOL CONFIGURATION DESCRIPTION
(B67798) OPEN MSFC TWT 549 LNCH PRESSURES T101R1S1 (UPPER WING)
(C67998) FLAGGED MSFC TWT 549 LNCH PRESSURES T101R1S1 (LOWER WING)

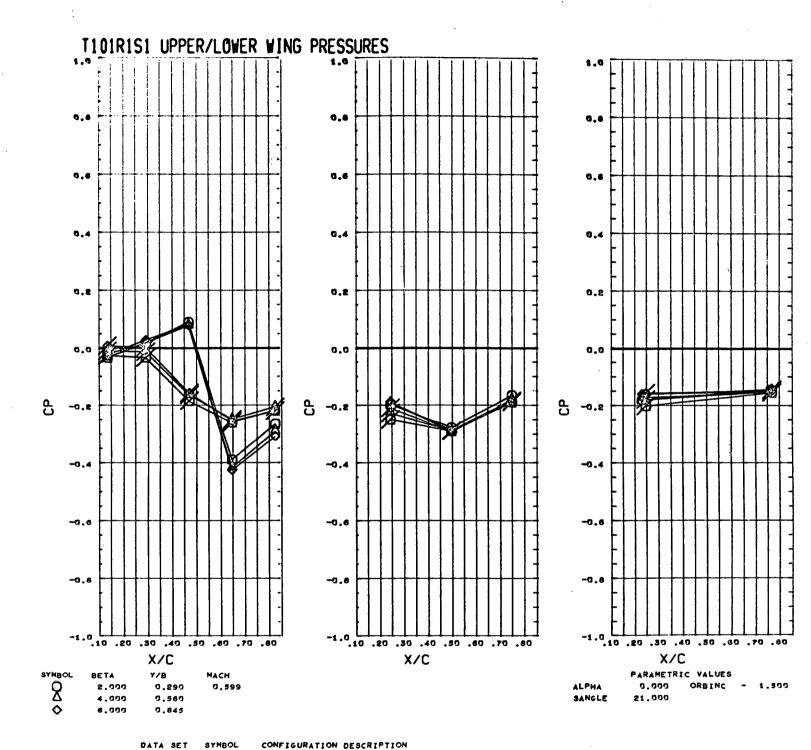


DATA SET SYMBOL CONFIGURATION DESCRIPTION
(867998) OPEN MSFC TWT 549 LNCH PRESSURES TIO1RIS1(UPPER WING)
(C67998) FLAGGED MSFC TWT 549 LNCH PRESSURES TIO1RIS1(LOWER WING)

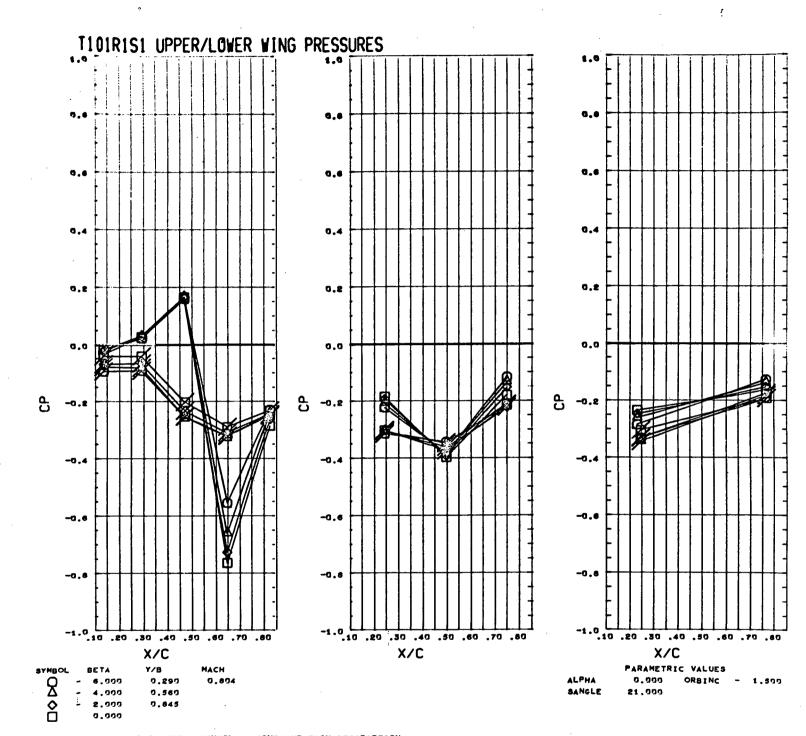


DATA SET SYMBOL CONFIGURATION DESCRIPTION

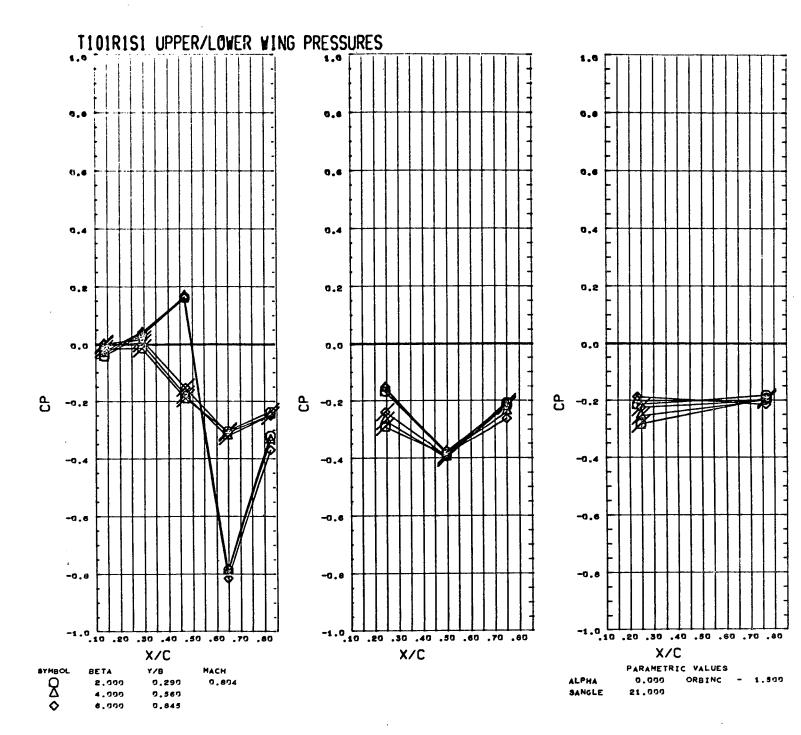
(867939) OPEN MSFC TWT 543 LNCH PRESSURES TIO1R131 (UPPER WING)
(C67939) FLAGGED MSFC TWT 543 LNCH PRESSURES TIO1R131 (LOWER WING)



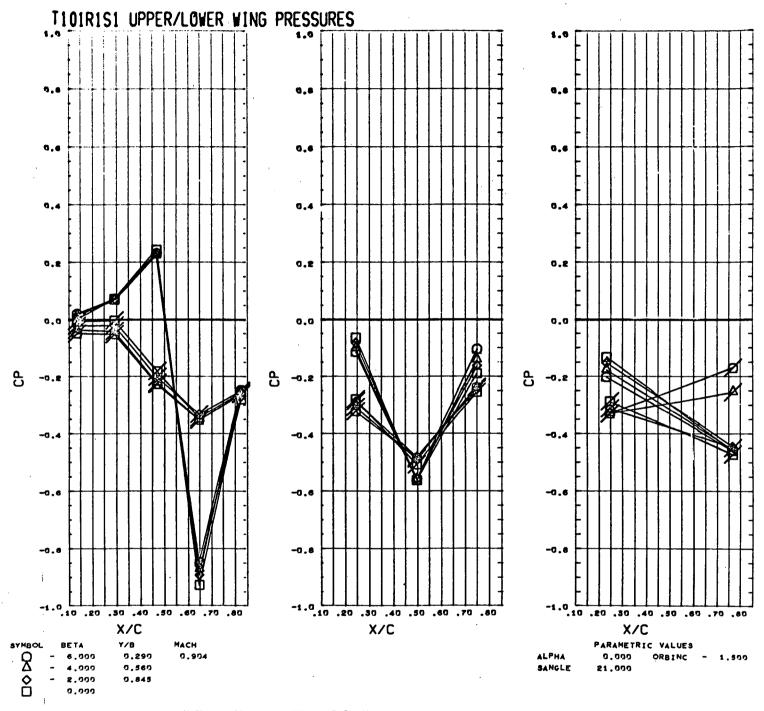
(867709) OPEN MSFC TWT 540 LNCH PRESSURES TIOIRISI (UPPER WING) (C67709) FLAGGED MSFC TWT 540 LNCH PRESSURES TIOIRISI (LOWER WING)



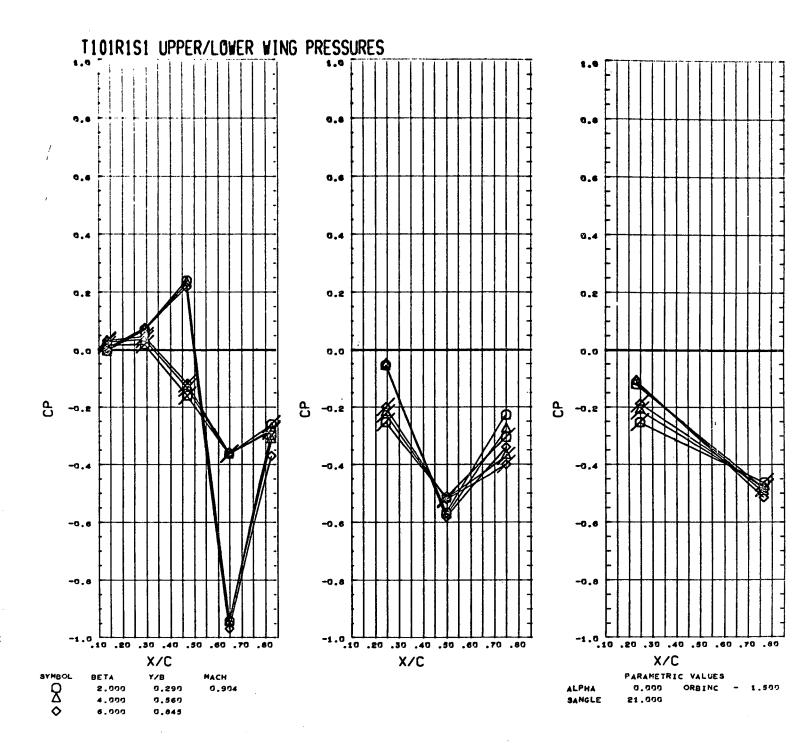
DATA SET SYMBOL CONFIGURATION DESCRIPTION
(867709) OPEN MSFC TWT 540 LNCH PRESSURES T101R1S1 (UPPER WING)
(C67909) FLAGGED MSFC TWT 540 LNCH PRESSURES T101R1S1 (LOWER WING)



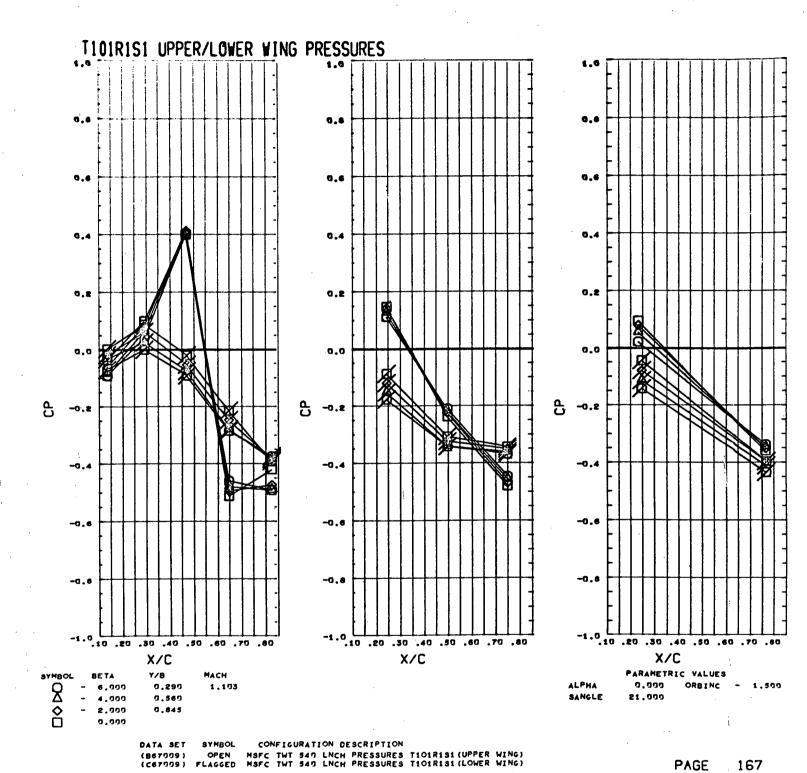
DATA SET SYMBOL CONFIGURATION DESCRIPTION
(867009) OPEN MSFC TWT 540 LNCH PRESSURES T101R1S1 (UPPER WING)
(C67009) FLAGGED MSFC TWT 540 LNCH PRESSURES T101R1S1 (LOWER WING)

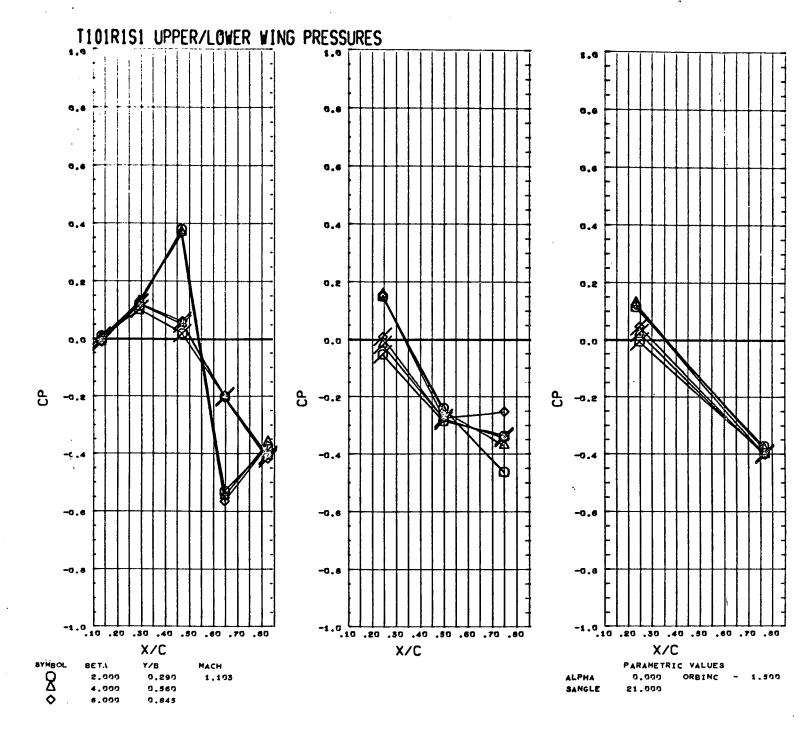


DATA SET SYMBOL CONFIGURATION DESCRIPTION
(867009) OPEN MSFC TWT 540 LNCH PRESSURES T101R1S1 (UPPER WING)
(C67009) FLAGGED MSFC TWT 540 LNCH PRESSURES T101R1S1 (LOWER WING)

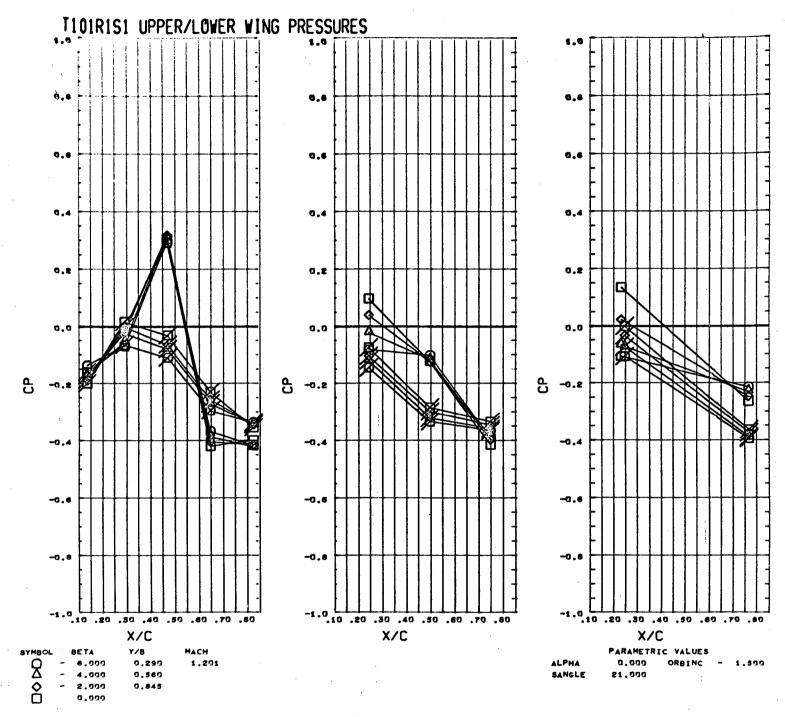


DATA SET SYMBOL CONFIGURATION DESCRIPTION
(867009) OPEN MSFC TWT 540 LNCH PRESSURES TIOIRISI(UPPER WING)
(C67009) FLAGGED MSFC TWT 540 LNCH PRESSURES TIOIRISI(LOWER WING)

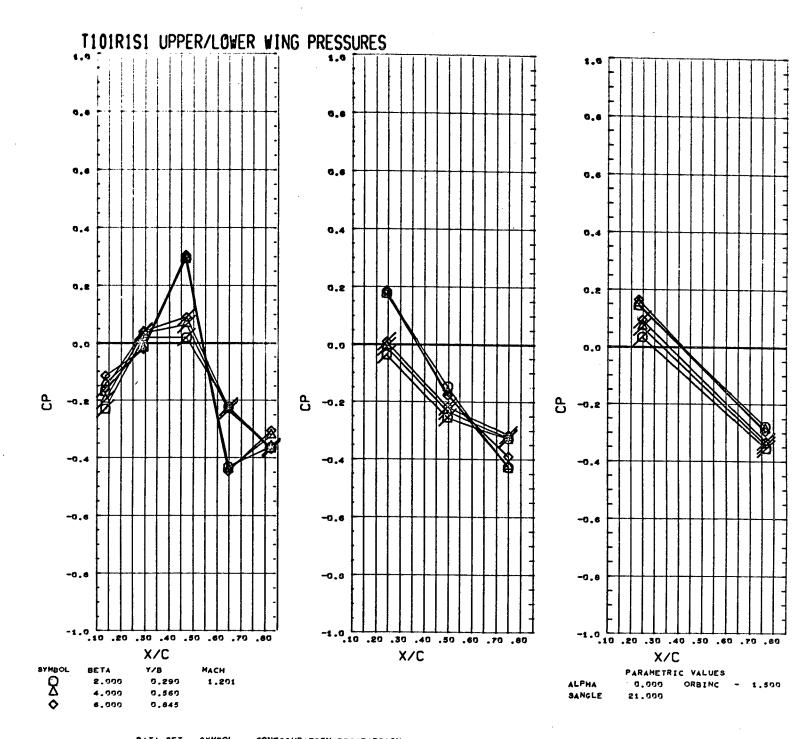




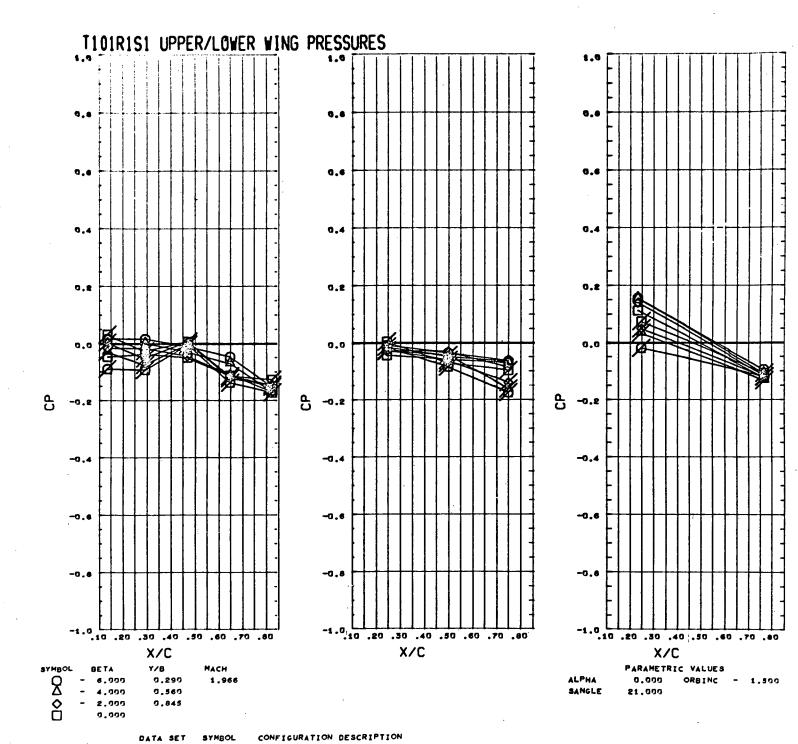
DATA SET SYMBOL CONFIGURATION DESCRIPTION (867999) OPEN MSFC TWT 549 LNCH PRESSURES TIOIRISI (UPPER WING) (C67999) FLAGGED MSFC TWT 549 LNCH PRESSURES TIOIRISI (LOWER WING)



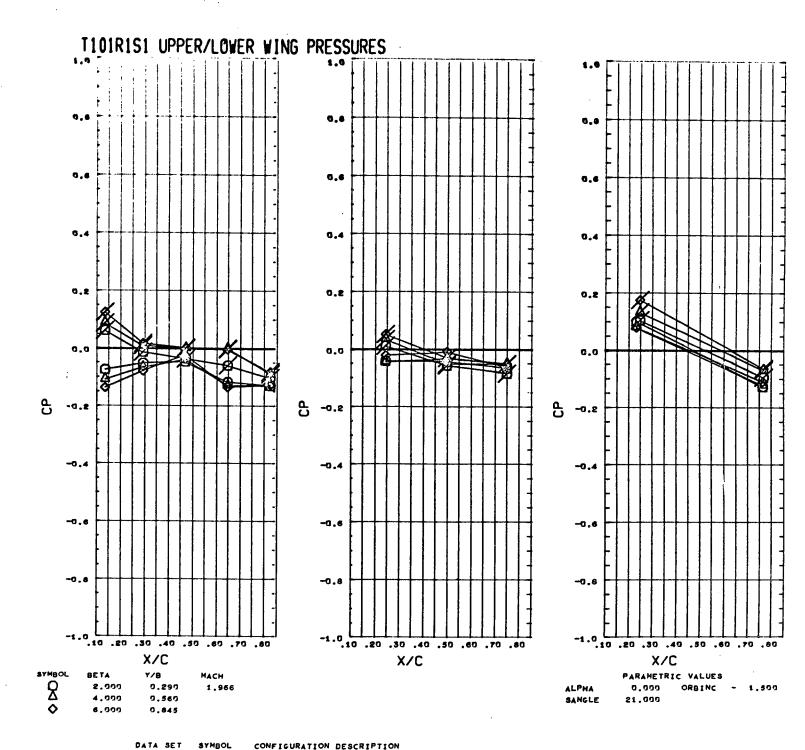
DATA SET SYMBOL CONFIGURATION DESCRIPTION
(867009) OPEN MSFC TWT 540 LNCH PRESSURES T101R1S1 (UPPER WING)
(C67009) FLAGGED MSFC TWT 540 LNCH PRESSURES T101R1S1 (LOWER WING)



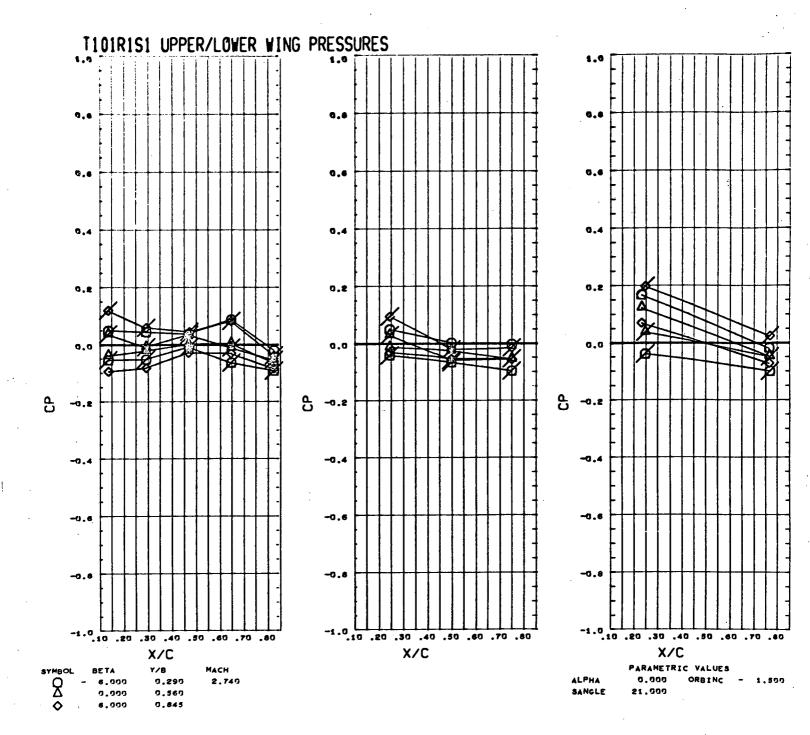
DATA SET SYMBOL CONFIGURATION DESCRIPTION
(867999) OPEN MSFC TWT 549 LNCH PRESSURES TIO1RIS1(UPPER WING)
(C67999) FLAGGED MSFC TWT 549 LNCH PRESSURES TIO1RIS1(LOWER WING)



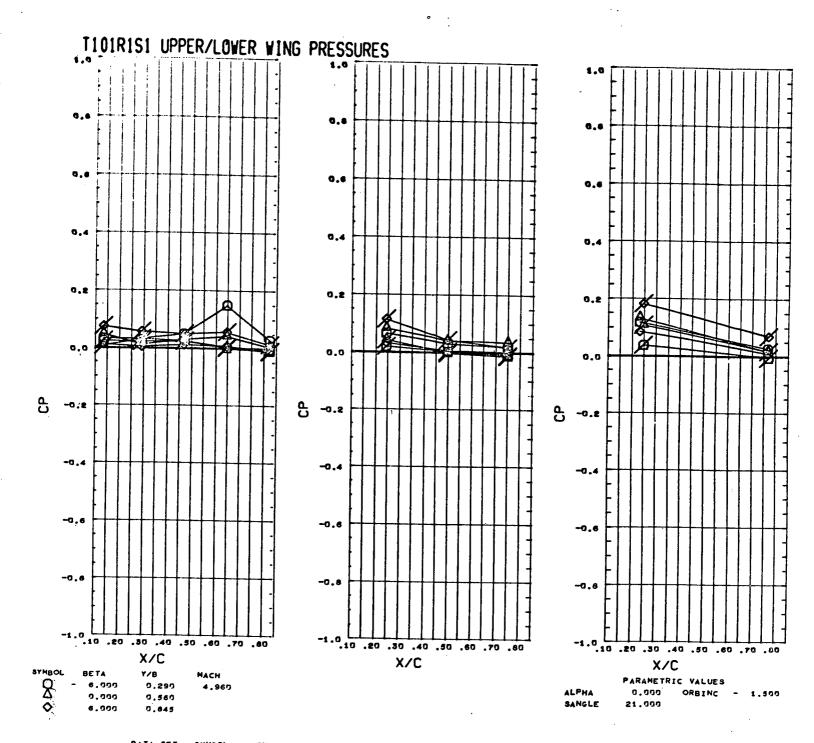
(867999) OPEN MSFC TWT 549 LNCH PRESSURES T101R131 (UPPER WING) (C67999) FLAGGED MSFC TWT 549 LNCH PRESSURES T101R131 (LOWER WING)



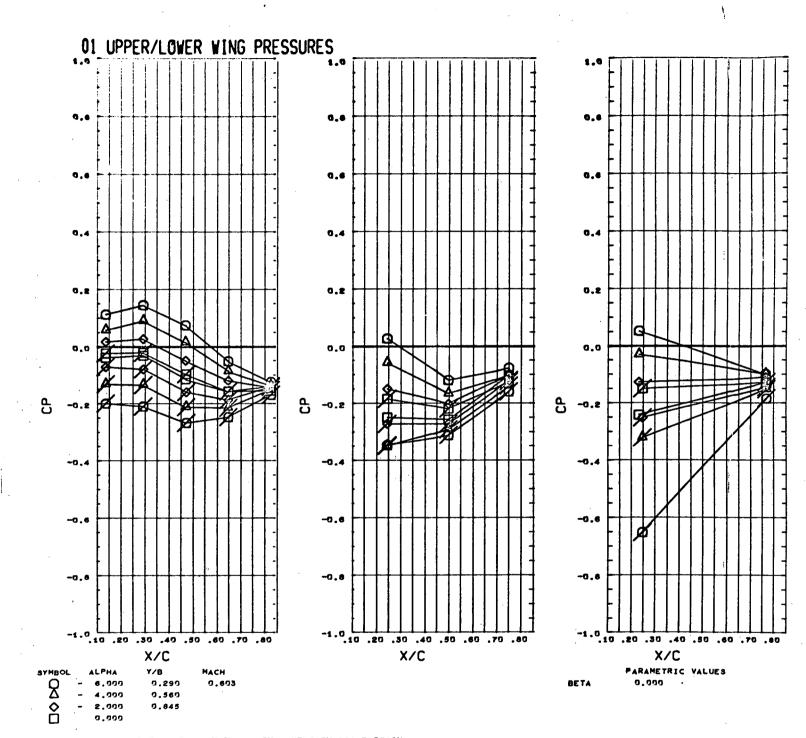
DATA SET SYMBOL CONFIGURATION DESCRIPTION
(867999) OPEN MSFC TWT 549 LNCH PRESSURES T101R1S1 (UPPER WING)
(C67999) FLAGGED MSFC TWT 549 LNCH PRESSURES T101R1S1 (LOWER WING)



DATA SET SYMBOL CONFIGURATION DESCRIPTION
(867010) OPEN MSFC TWT 540 LNCH PRESSURES T101R1S1 (UPPER WING)
(C67010) FLAGGED MSFC TWT 540 LNCH PRESSURES T101R1S1 (LOWER WING)

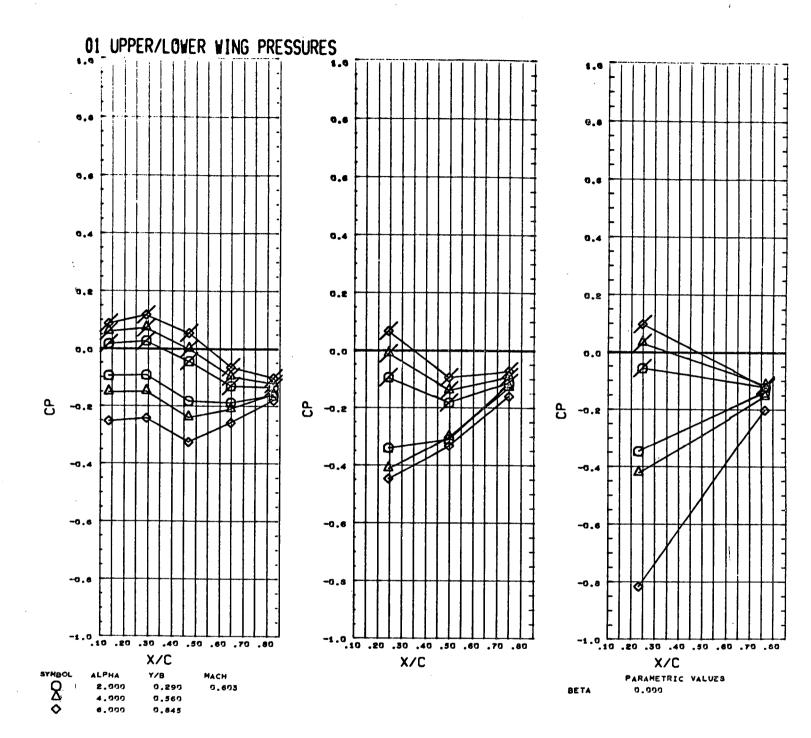


DATA SET SYMBOL CONFIGURATION DESCRIPTION
(867919) OPEN MSFC TWT 549 LNCH PRESSURES TIOIRISI (UPPER WING)
(C67919) FLAGGED MSFC TWT 549 LNCH PRESSURES TIOIRISI (LOWER WING)

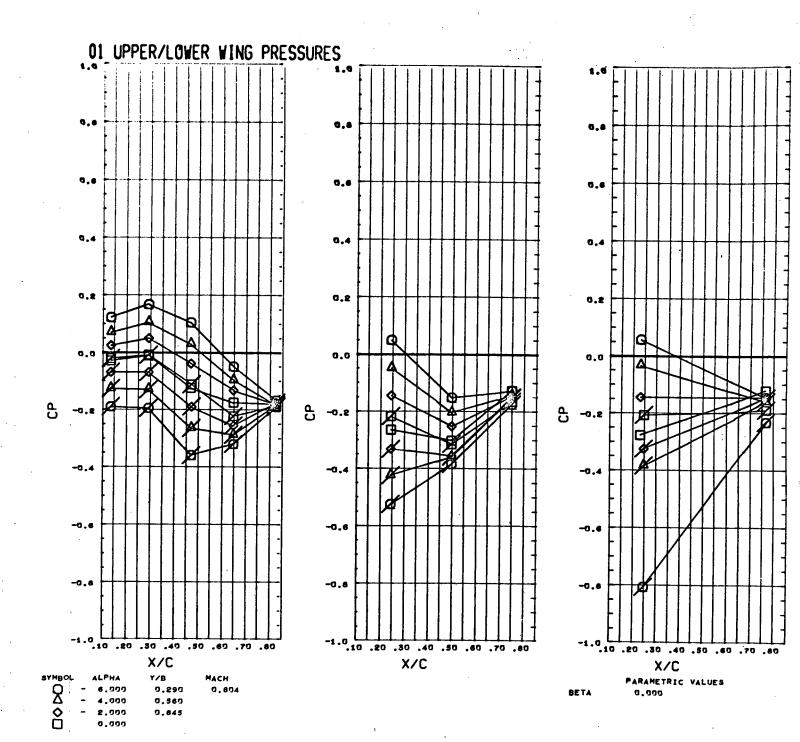


DATA SET SYMBOL CONFIGURATION DESCRIPTION

(867011) OPEN MSFC TWT 540 LAUNCH PRESSURES O1 (UPPER WING)
(C67011) FLAGGED MSFC TWT 540 LAUNCH PRESSURES O1 (LOWER WING)



DATA SET SYMBOL CONFIGURATION DESCRIPTION
(867911) OPEN MSFC TWT 549 LAUNCH PRESSURES O1 (UPPER WING)
(C67911) FLAGGED MSFC TWT 549 LAUNCH PRESSURES O1 (LOWER WING)



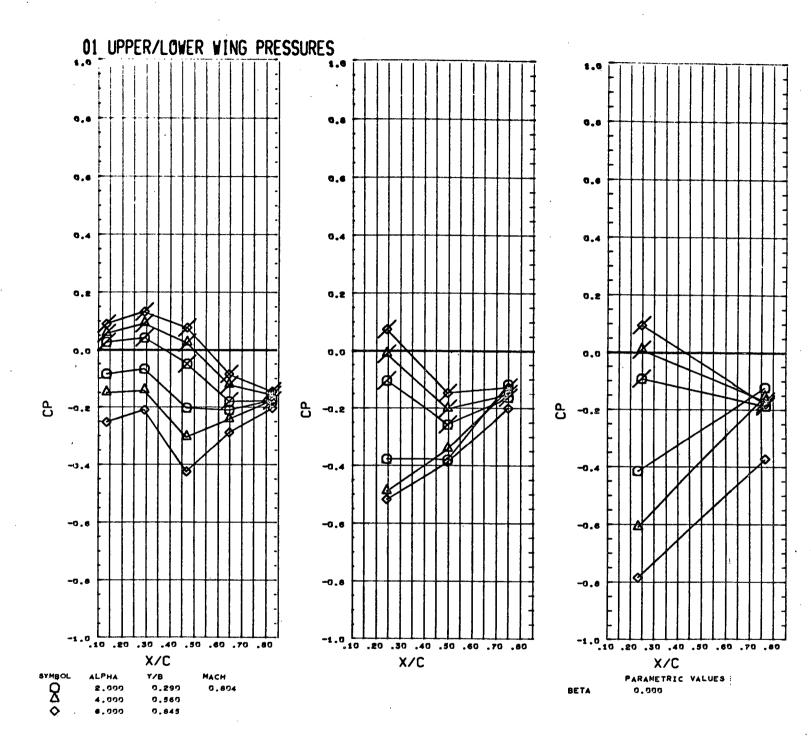
DATA SET SYMBOL CONFIGURATION DESCRIPTION

(B67911) OPEN MSFC TWT 549 LAUNCH PRESSURES O1 (UPPER WING)

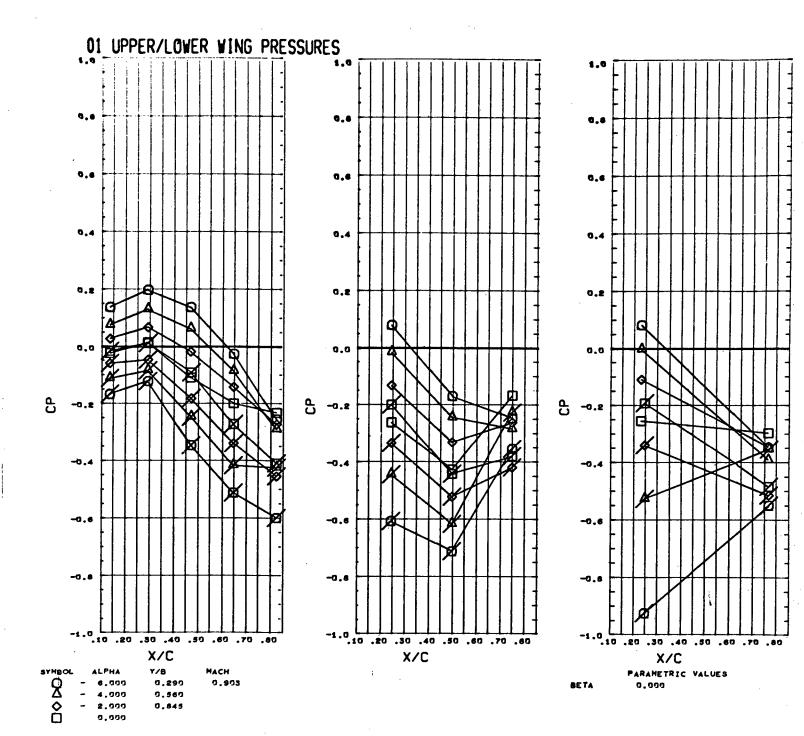
(C67911) FLAGGED MSFC TWT 549 LAUNCH PRESSURES O1 (LOWER WING)

PAGE

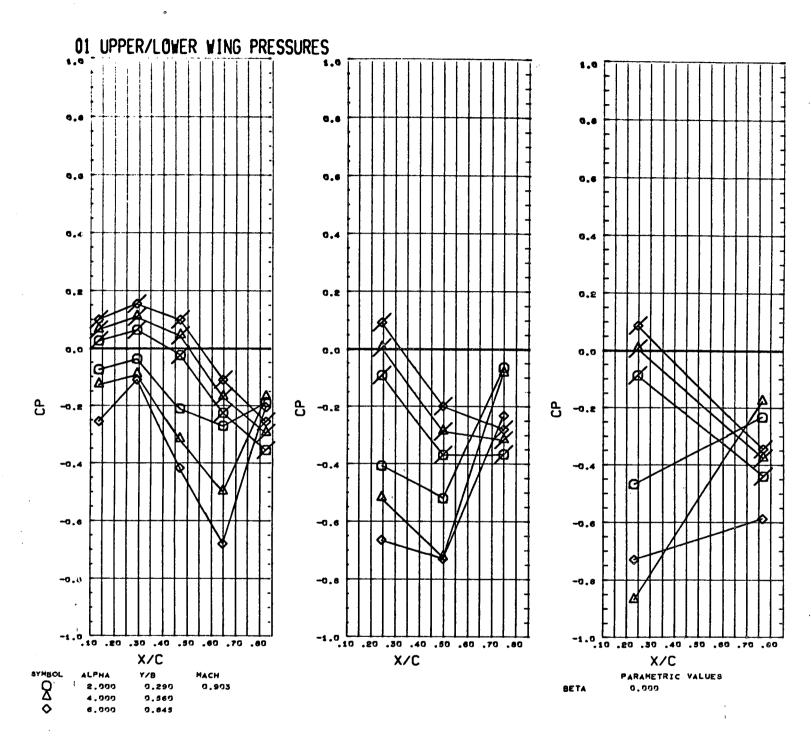
177



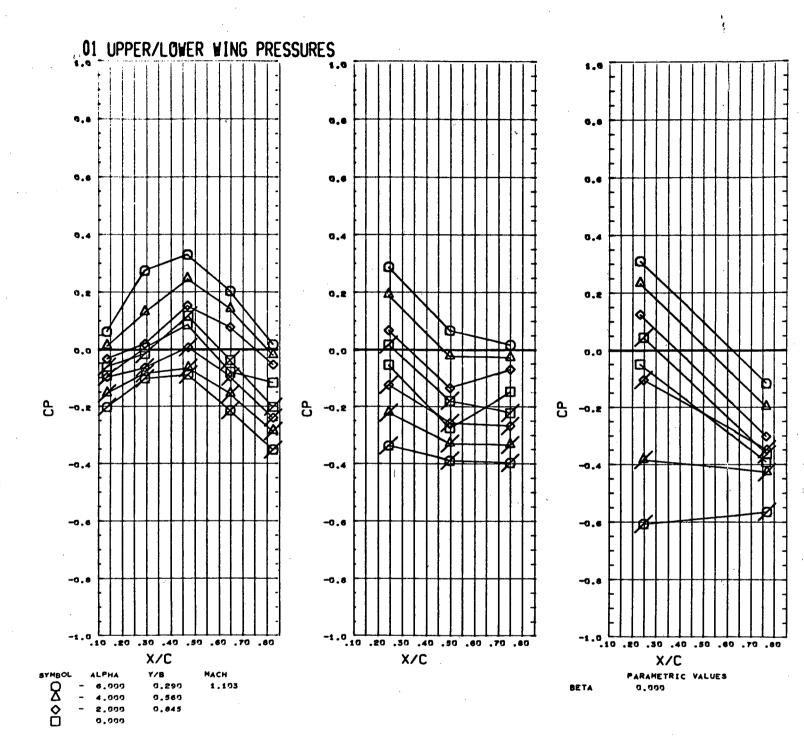
DATA SET SYMBOL CONFIGURATION DESCRIPTION
(B67011) OPEN MSFC TWT 540 LAUNCH PRESSURES O1 (UPPER WING)
(C67011) FLAGGED MSFC TWT 540 LAUNCH PRESSURES O1 (LOWER WING)



DATA SET SYMBOL CONFIGURATION DESCRIPTION
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(C67711) FLAGGED MSFC TWT 547 LAUNCH PRESSURES O1 (LOWER WING)



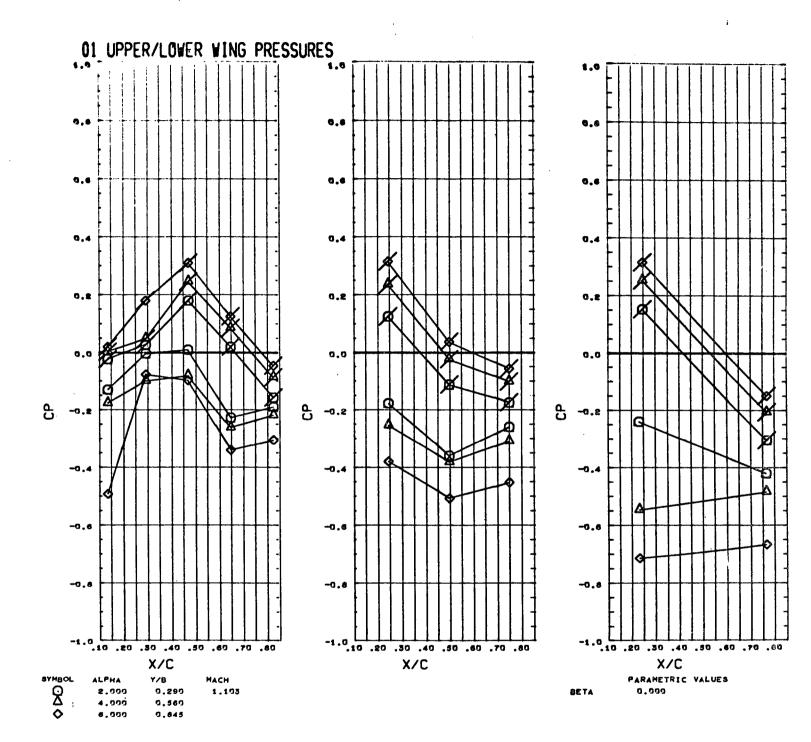
DATA SET SYMBOL CONFIGURATION DESCRIPTION
(867911) OPEN MSFC TWT 540 LAUNCH PRESSURES O1 (UPPER WING)
(C67911) FLAGGED MSFC TWT 540 LAUNCH PRESSURES O1 (LOWER WING)



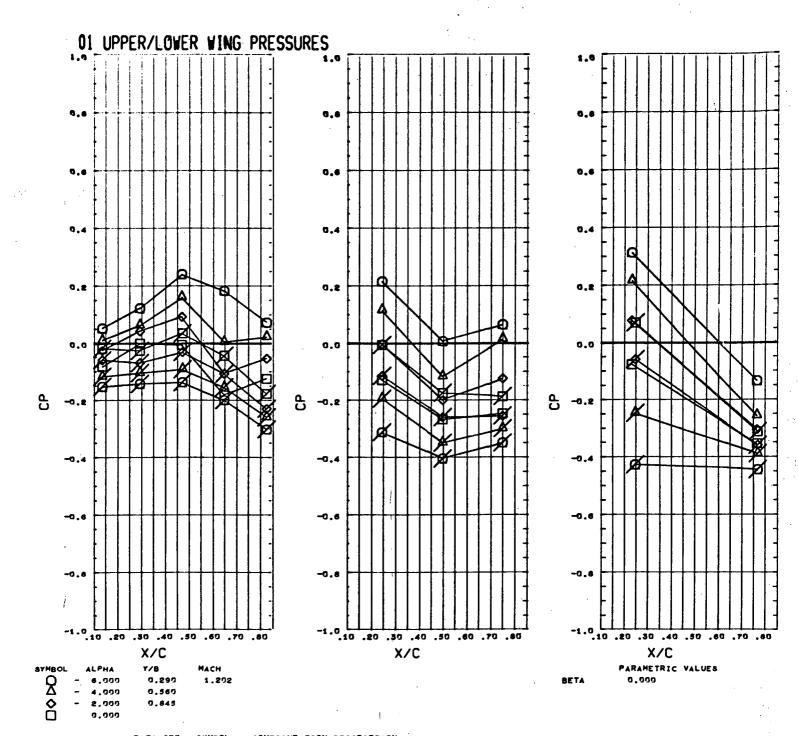
DATA SET SYMBOL CONFIGURATION DESCRIPTION

(867911) OPEN MSFC TWT 549 LAUNCH PRESSURES O1 (UPPER WING)

(C67911) FLAGGED MSFC TWT 549 LAUNCH PRESSURES O1 (LOWER WING)

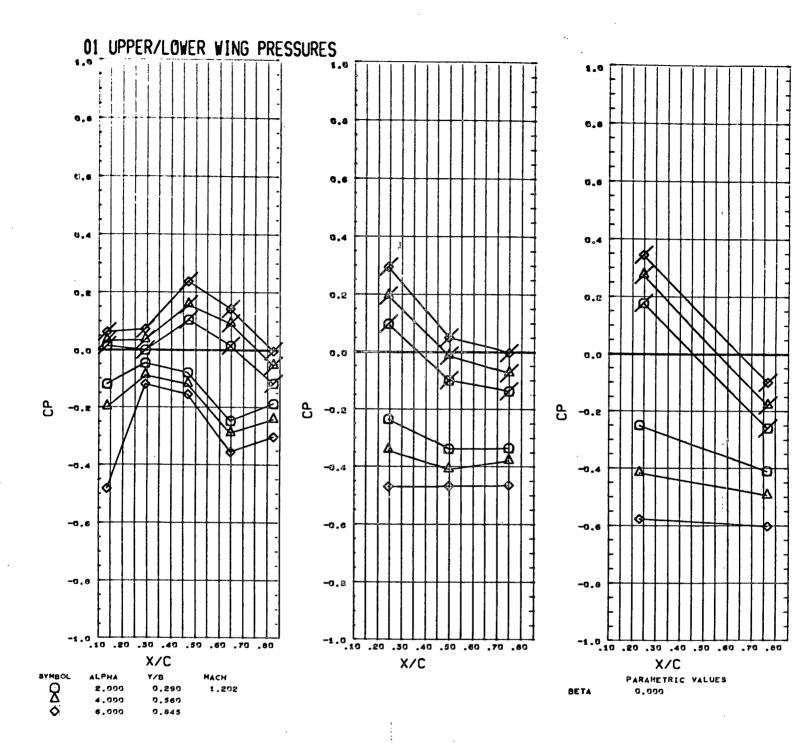


DATA SET SYMBOL CONFIGURATION DESCRIPTION
(867911) OPEN MSFC TWT 549 LAUNCH PRESSURES O1 (UPPER WING)
(C67911) FLAGGED MSFC TWT 549 LAUNCH PRESSURES O1 (LOWER WING)

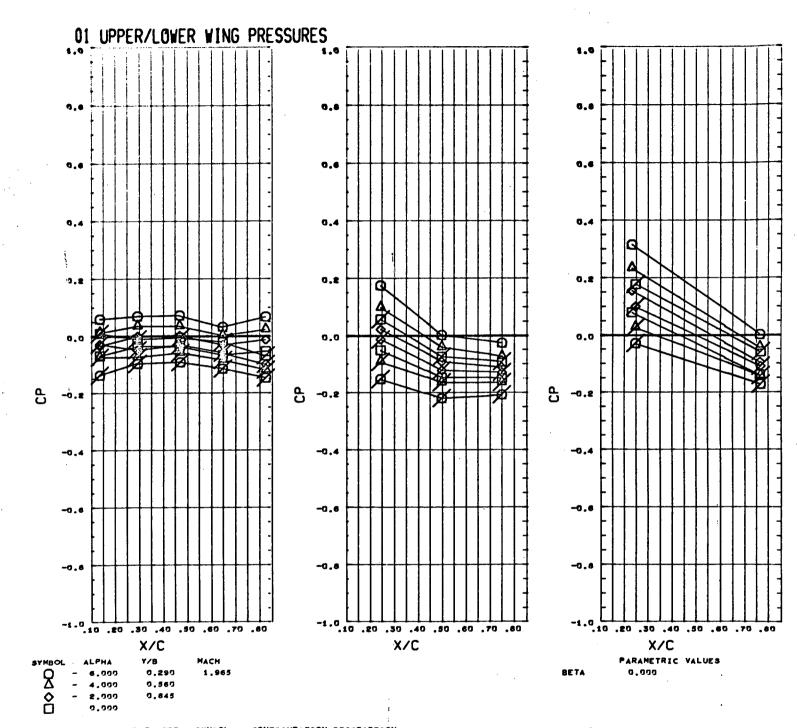


DATA SET SYMBOL CONFIGURATION DESCRIPTION

(867011) OPEN MSFC TWT 540 LAUNCH PRESSURES 01 (UPPER WING)
(C67011) FLAGGED MSFC TWT 540 LAUNCH PRESSURES 01 (LOWER WING)



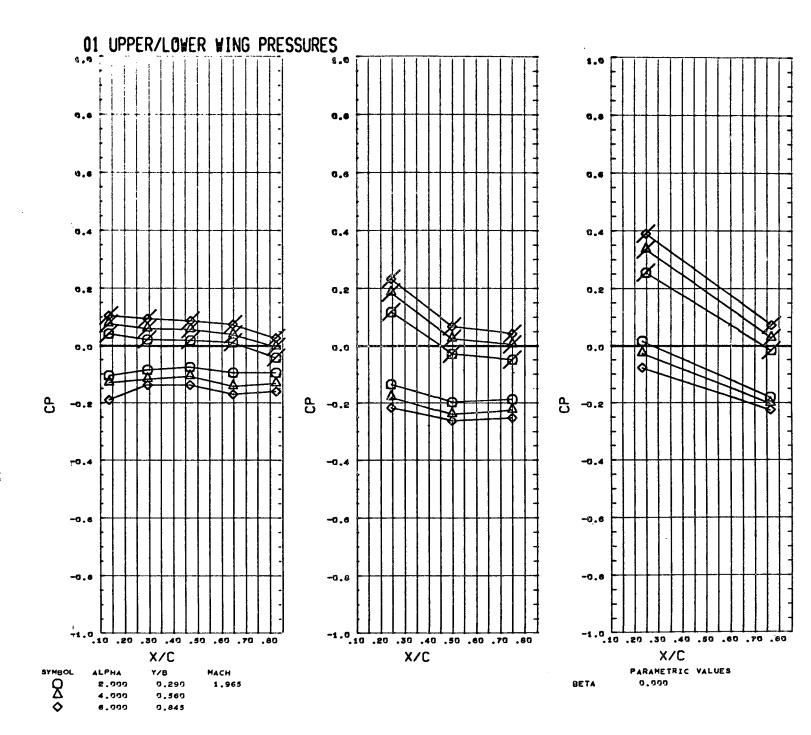
DATA SET SYMBOL CONFIGURATION DESCRIPTION
(BG7011) OPEN MSFC THT 540 LAUNCH PRESSURES O1 (UPPER WING)
(C67011) FLAGGED MSFC THT 540 LAUNCH PRESSURES O1 (LOWER WING)



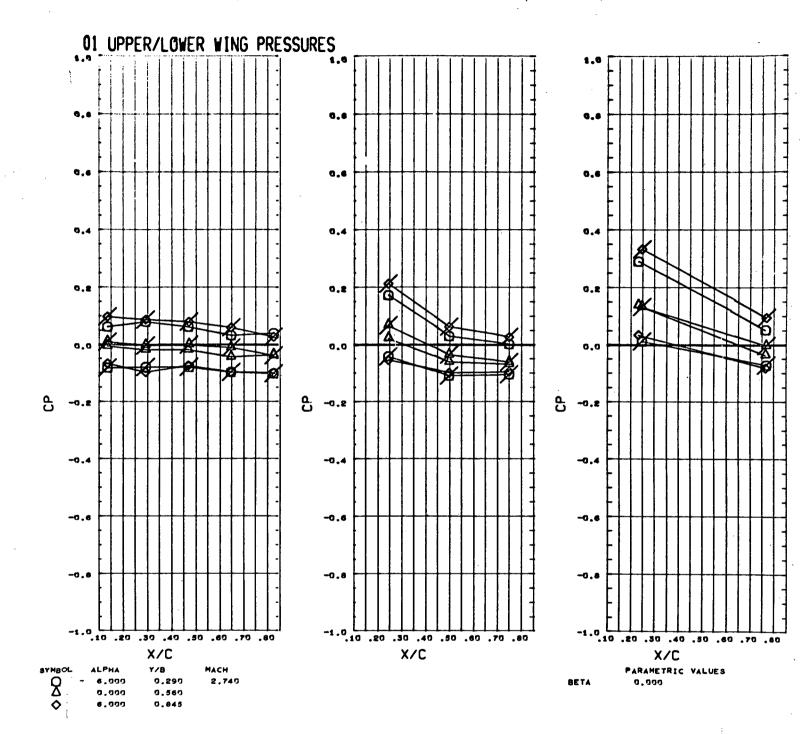
DATA SET SYMBOL CONFIGURATION DESCRIPTION

(867011) OPEN MSFC TWT 540 LAUNCH PRESSURES O1 (UPPER WING)

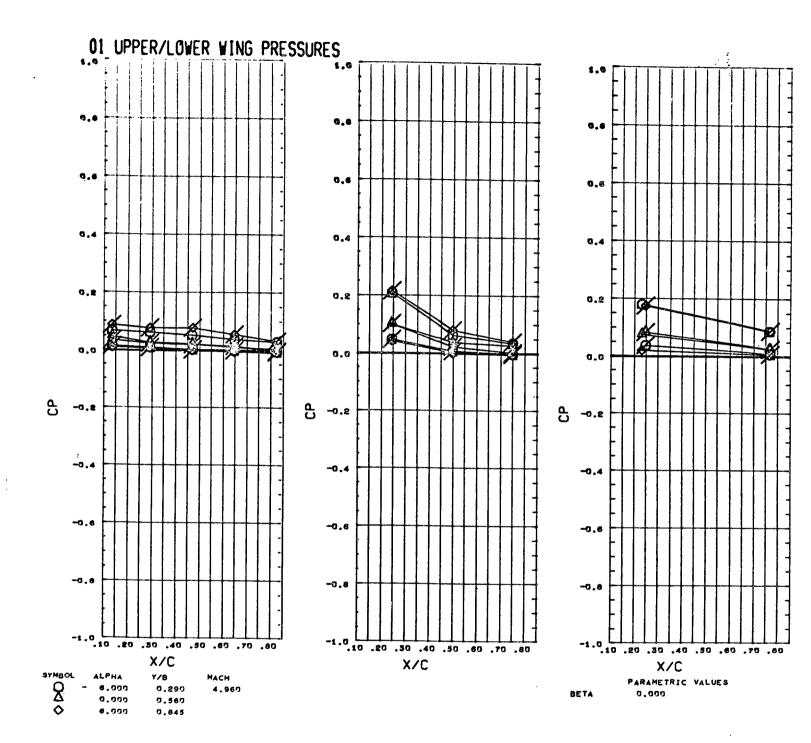
(C67011) FLAGGED MSFC TWT 540 LAUNCH PRESSURES O1 (LOWER WING)



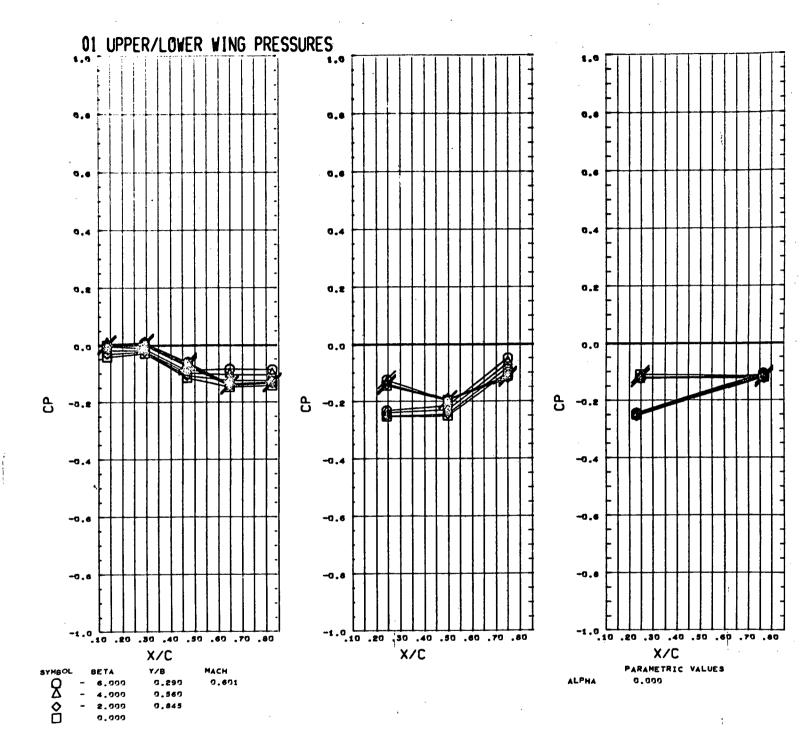
DATA SET SYMBOL CONFIGURATION DESCRIPTION
(867011) OPEN MSFC TWT 540 LAUNCH PRESSURES O1 (UPPER WING)
(C67011) FLAGGED MSFC TWT 540 LAUNCH PRESSURES O1 (LOWER WING)



DATA SET SYMBOL CONFIGURATION DESCRIPTION
(867012) OPEN MSFC TWT 540 LAUNCH PRESSURES O1 (UPPER WING)
(C67012) FLAGGED MSFC TWT 540 LAUNCH PRESSURES O1 (LOWER WING)



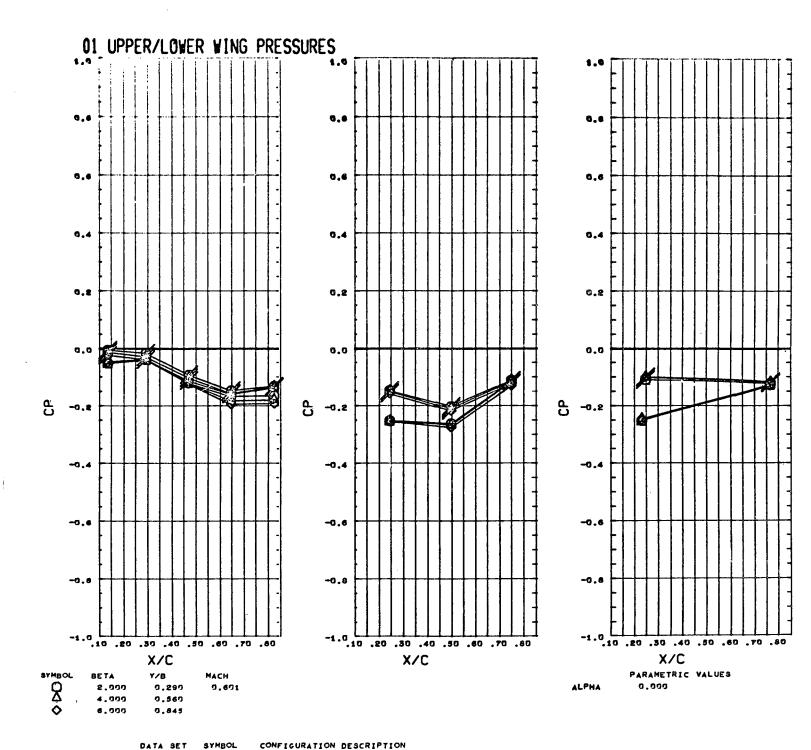
DATA SET SYMBOL CONFIGURATION DESCRIPTION
(867912) OPEN MSFC TWT 549 LAUNCH PRESSURES O1 (UPPER WING)
(C67912) FLAGGED MSFC TWT 549 LAUNCH PRESSURES O1 (LOWER WING)

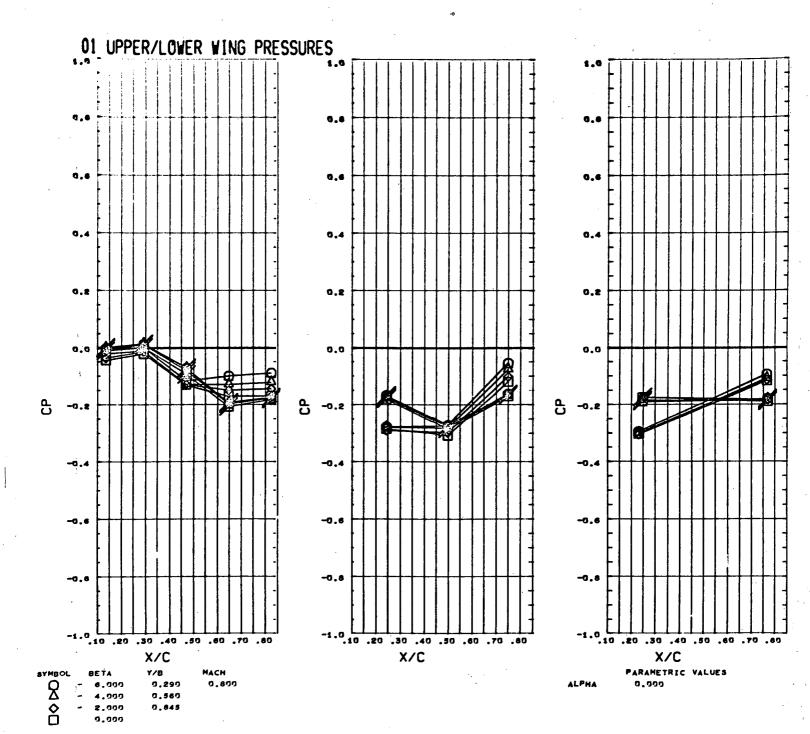


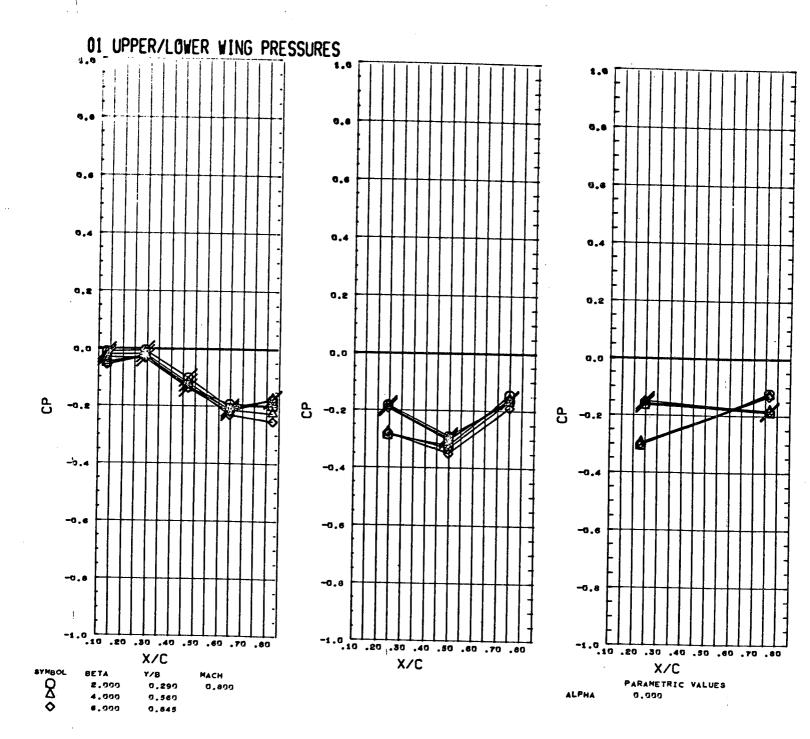
DATA SET SYMBOL CONFIGURATION DESCRIPTION
(867013) OPEN MSFC TWT 540 LAUNCH PRESSURES O1 (UPPER WING)
(C67013) FLAGGED MSFC TWT 540 LAUNCH PRESSURES O1 (LOWER WING)

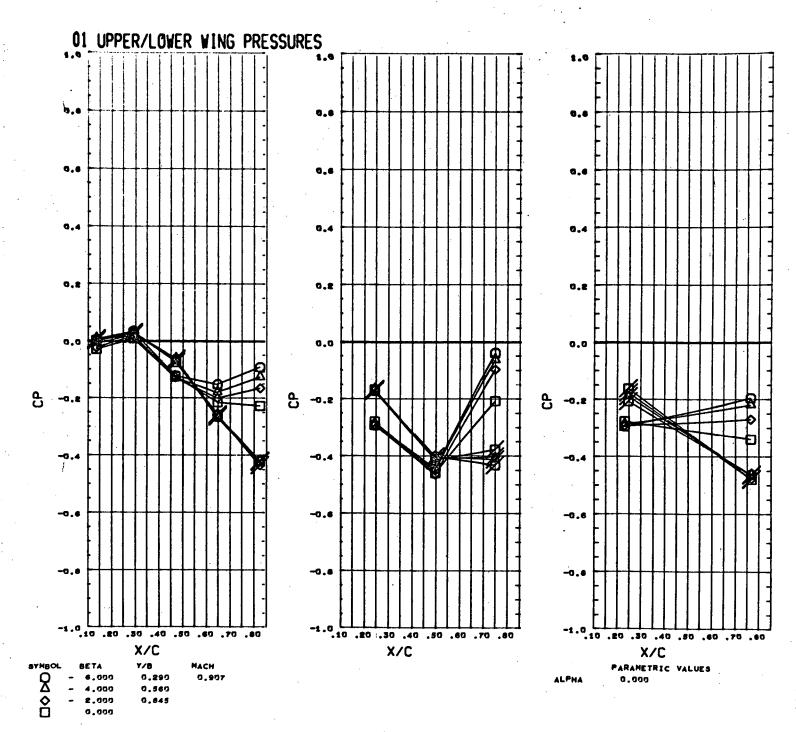
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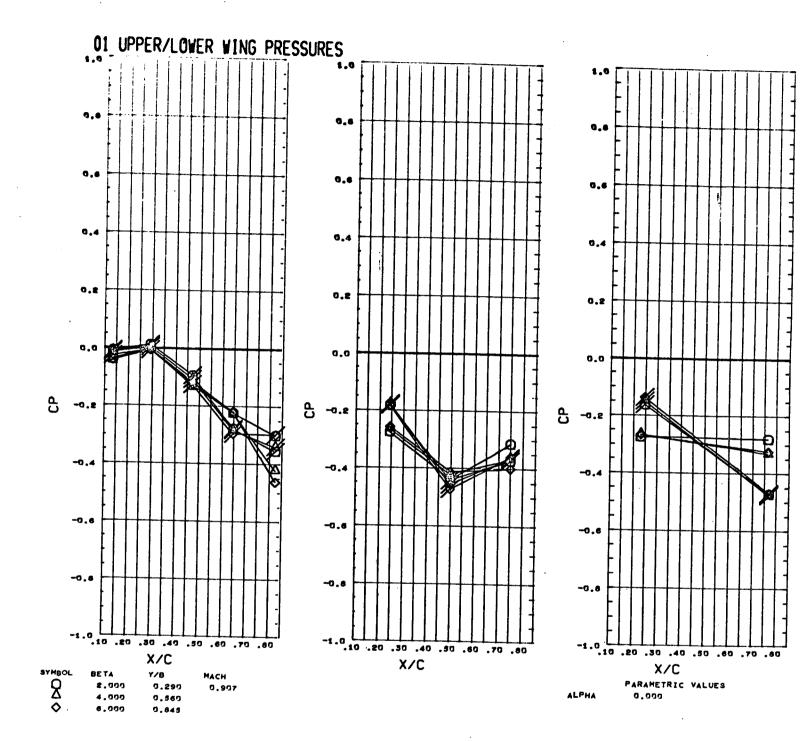
189

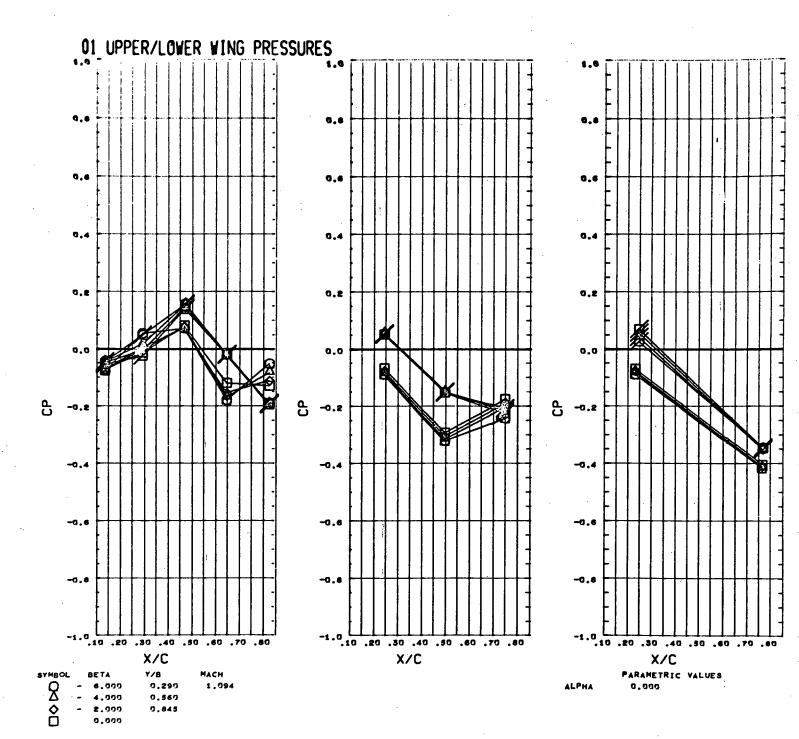






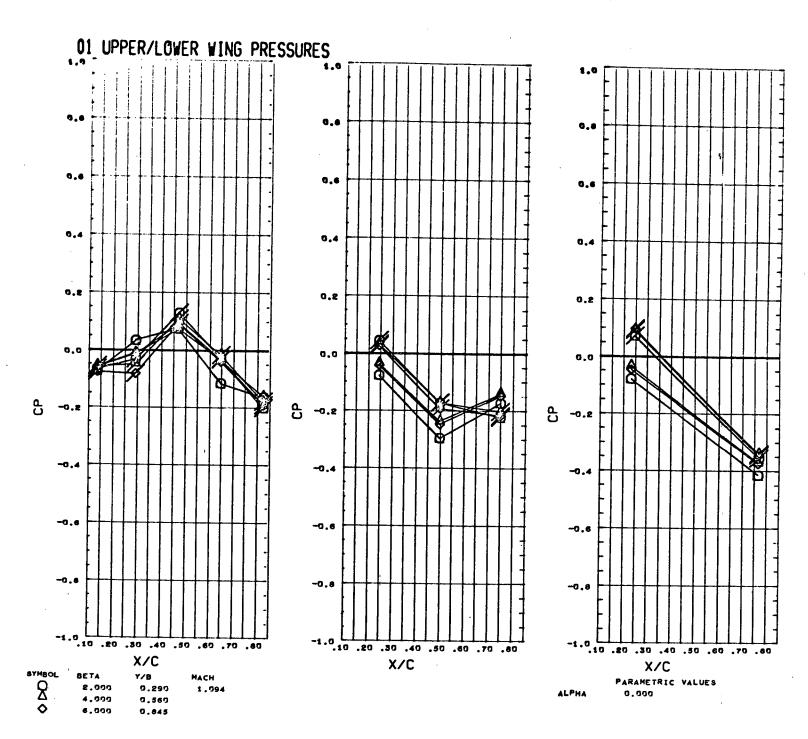


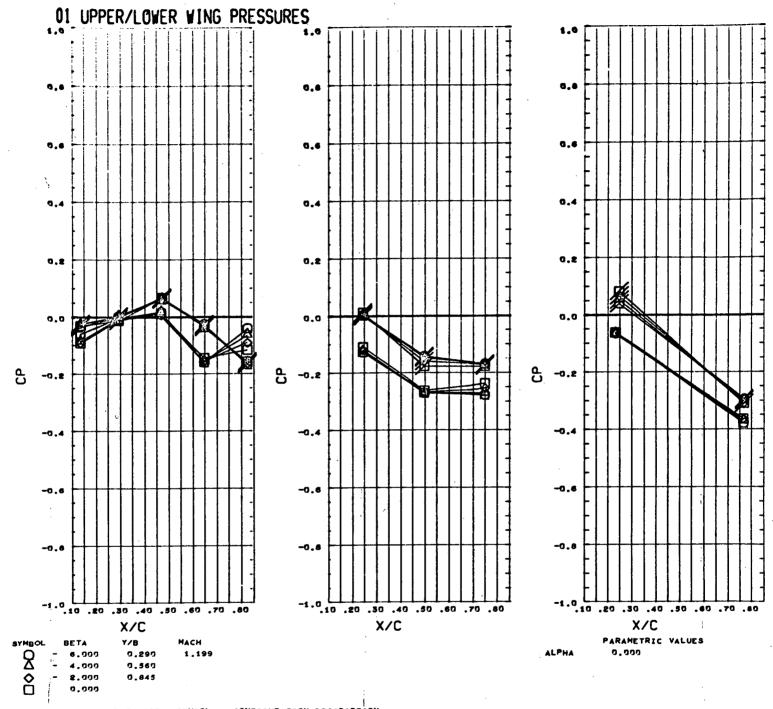




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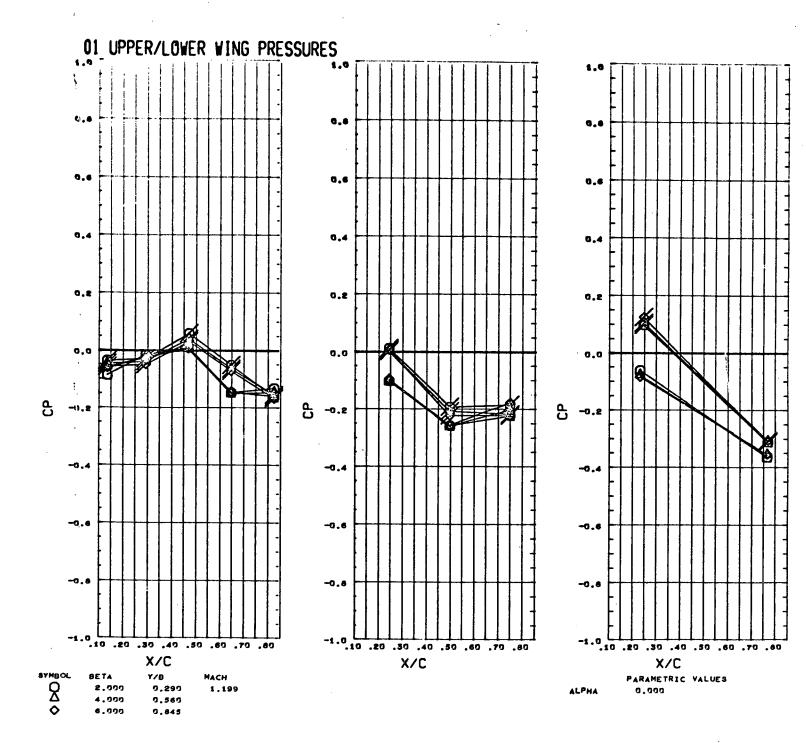
195



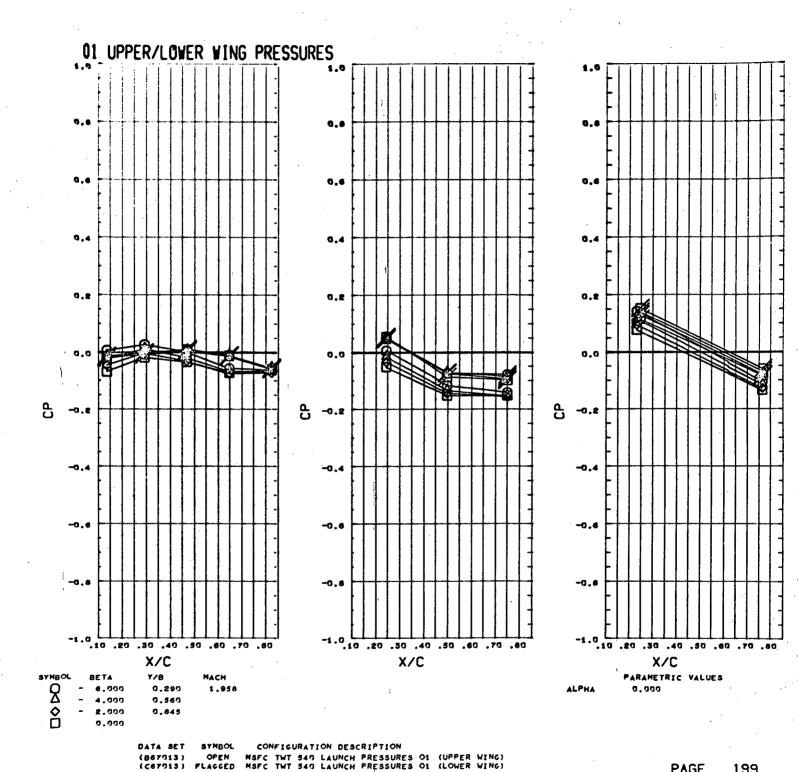


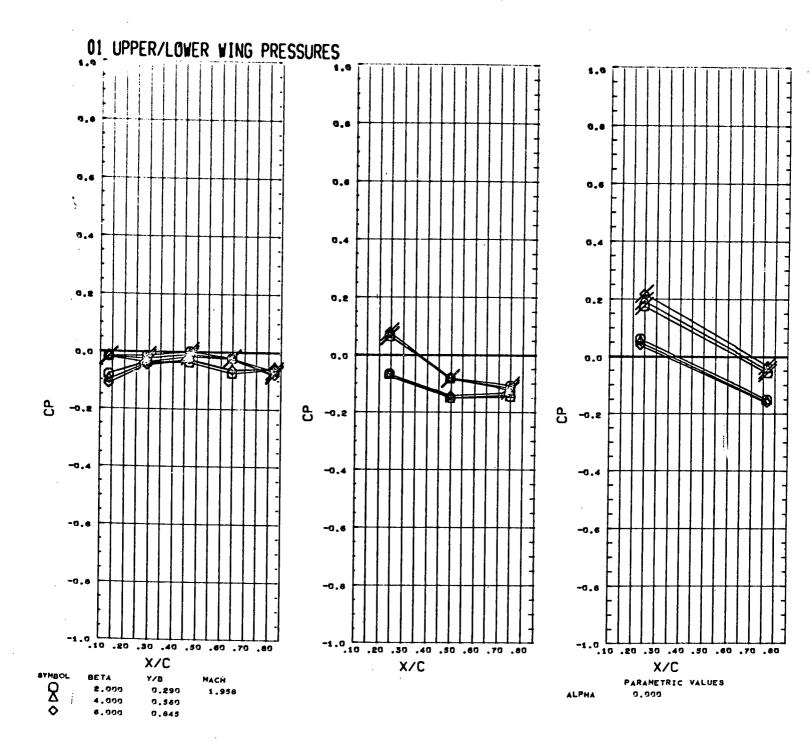
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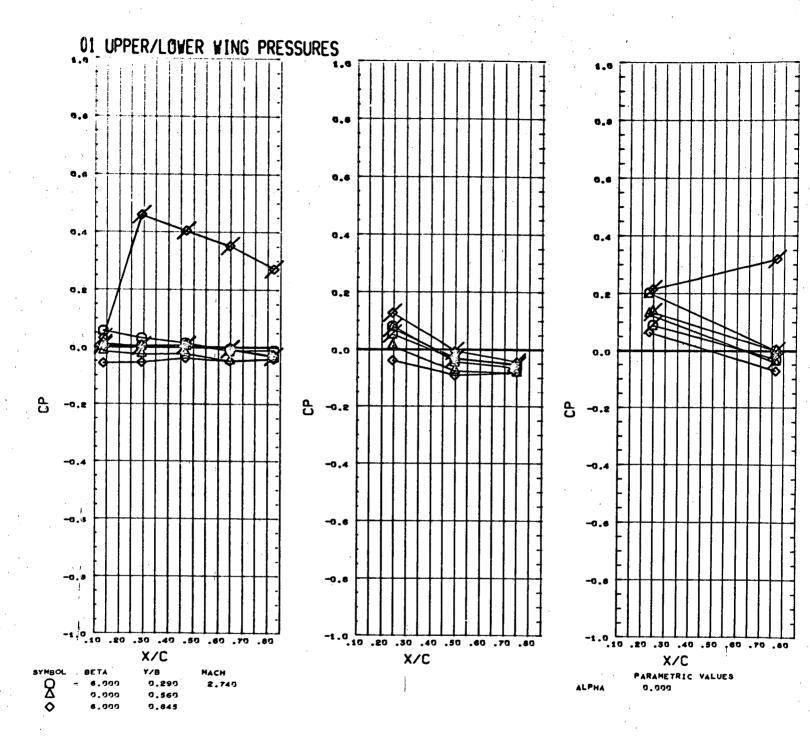
197

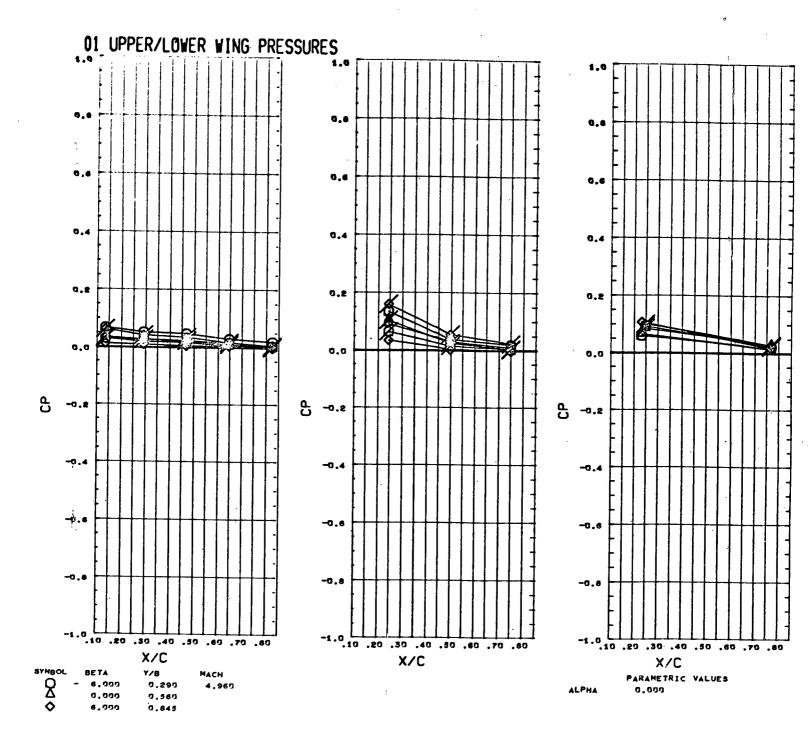


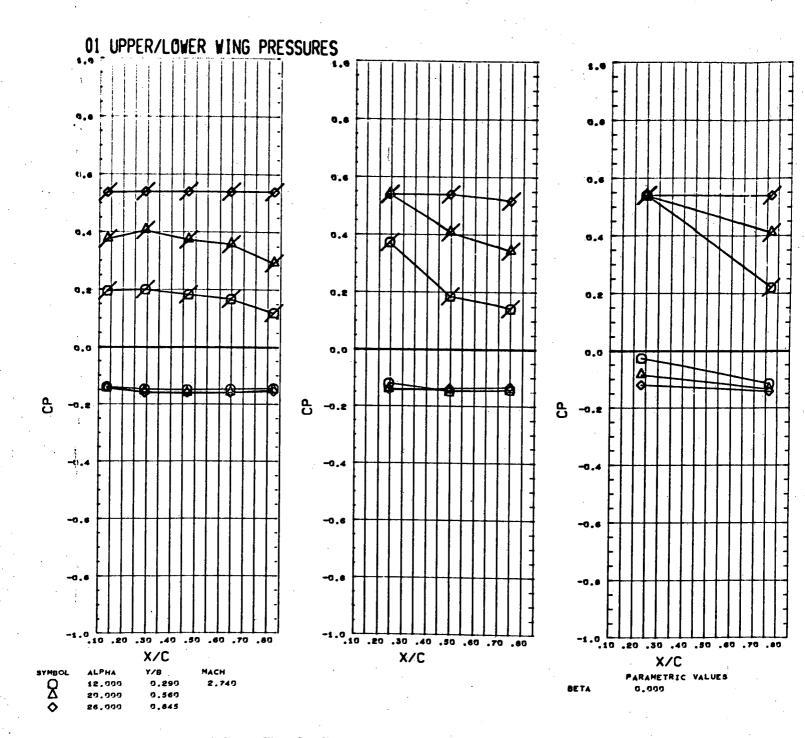


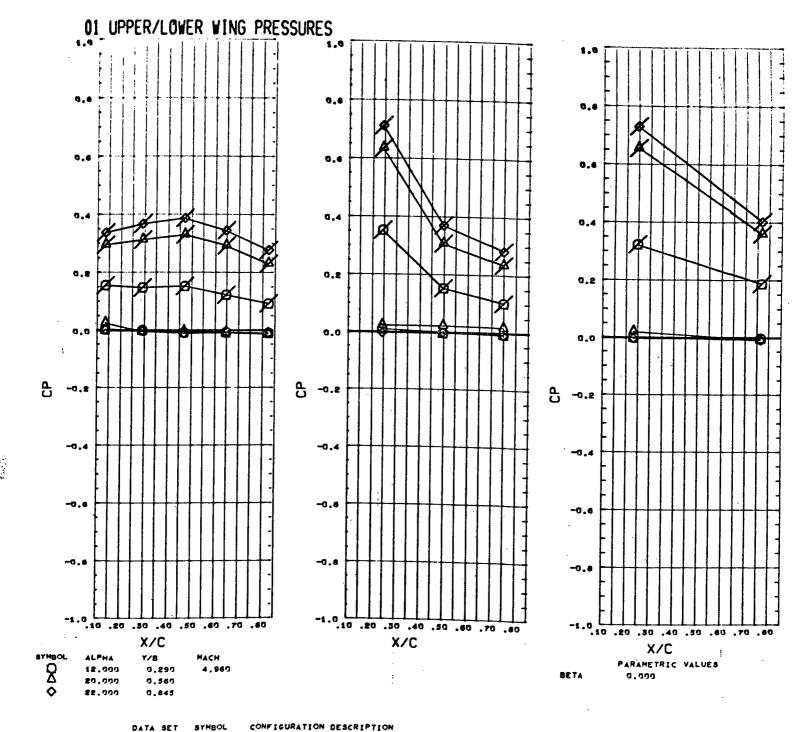












(6867016) OPEN MSFC TWT 549 LAUNCH PRESSURES O1 (UPPER WING) (C67016) FLAGGED MSFC TWT 549 LAUNCH PRESSURES O1 (LOWER WING)